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A DISTRICT POWER SUPPLY

From Palmer, Mass., to Surrounding Territory for Lighting, Factory Power and Railways

NEW ENGLAND, LAND OF beautiful hills and picturesque valleys, and of clear, flowing streams, has, for centuries, utilized only a small part of the flood of energy which courses in its veins. Although manufacturing has long been a leading industry, and small water powers were early used, large developments have waited the coming of the newer spirit, which is now arising throughout "Yankeeland" to bring its institutions into the very front rank of the country's progress.

Rapid expansion of the manufacturing industries in the early days, made the single falls, which had not been developed, inadequate to supply the needed power, and the steam engine came forward to solve the problem. Electric transmission was not then dreamt of, and no means was known of bringing to the busy manufacturing centers located on the railroads, the power which was running waste back in the hills.

Another thing, in the days that manufacturing industries of New England began to develop, it was not a time of making a big industrial plant by working overnight, but industries grew up around some one man especially capable of developing them, and, naturally, were located at the point where he happened to live. As a result, small manufacturing towns were the rule, each one with a specialized industry, and as those living in and near the town became skilled in various branches of manufacture, the plant increased and divided to form new plants, but always retaining their early location.

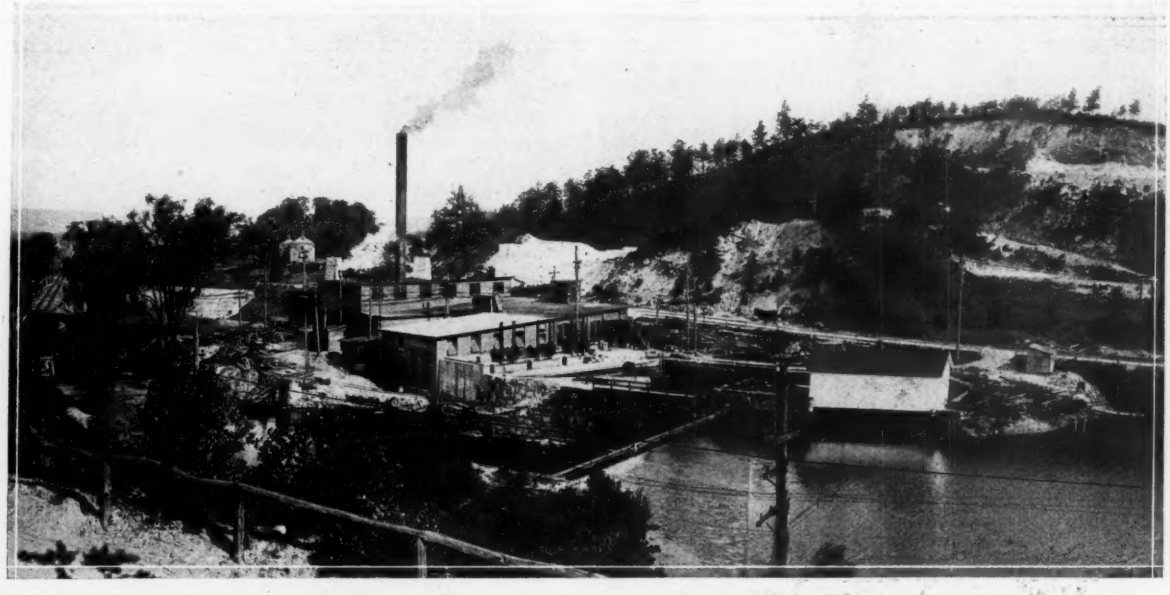


FIG. 1A. CENTRAL MASSACHUSETTS ELECTRIC CO. STEAM TURBINE AND WATER POWER PLANTS

New England hills are not easy for a railroad to climb, and as a considerable head of water is neces-

sary to give large water power, it followed that most of the sites suited to the water power development were away from the centers where the industries had planted themselves. In the early days, coal was not expensive, and the need for developing hydraulic power was not pressing. Now, with the increased cost of fuel and the wider outlook towards power when the hostile Indian was the chief consideration, high up so that a broad outlook over the valleys might be had, with power which shall do away with the drudgery of hauling up the hillside and burning the coal from the distant mines, or which shall supply to the descendants of the Pilgrim Fathers electrical conveniences, in the most up-to-date form.

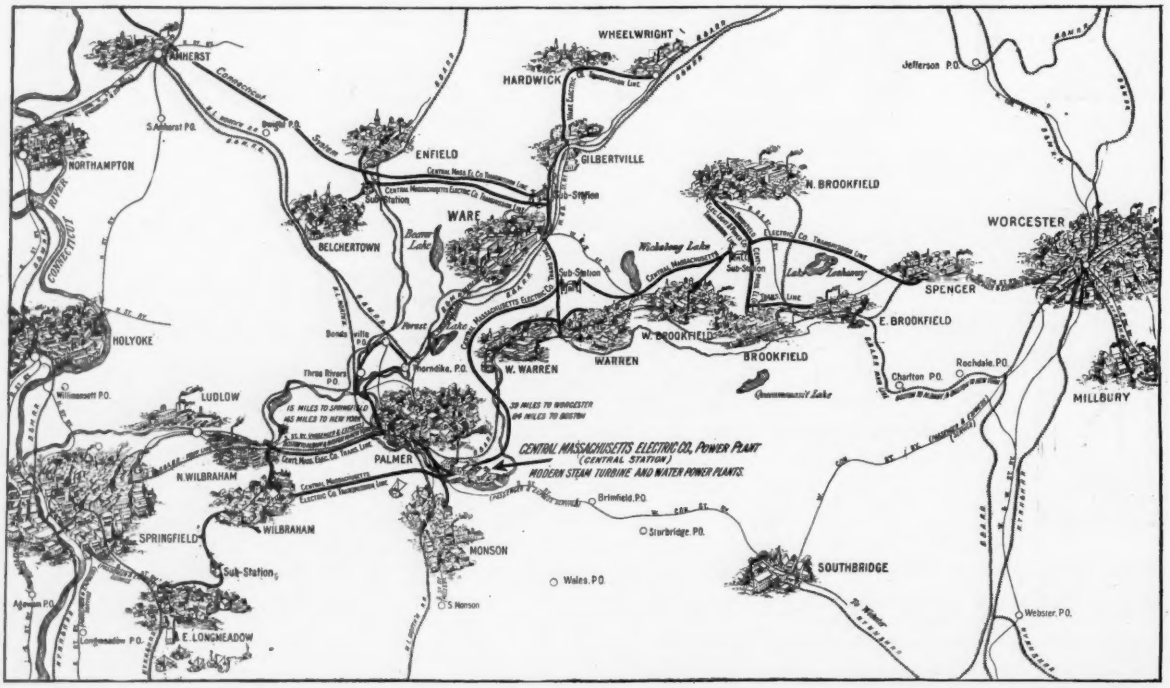


FIG. 1. TRANSMISSION SYSTEM OF CENTRAL MASSACHUSETTS ELECTRIC CO., SHOWING PLANT, SUBSTATIONS, LINES AND TOWNS SUPPLIED

station economy, comes the idea of large investment at points remote from the manufacturing centers, where power may be developed and transmitted at high voltage to the point where human need can utilize it. The modern methods have aroused New England to take account of its resources, and turn its streams into gold.

One such development has been made at Palmer, near the southern boundary line of Massachusetts, and about ⅔ of the way from east to west. It is located, as will be seen from the map of the transmission lines,

FIG. 1B. WATER-WHEEL GENERATOR, GOVERNOR AND BELTED EXCITER

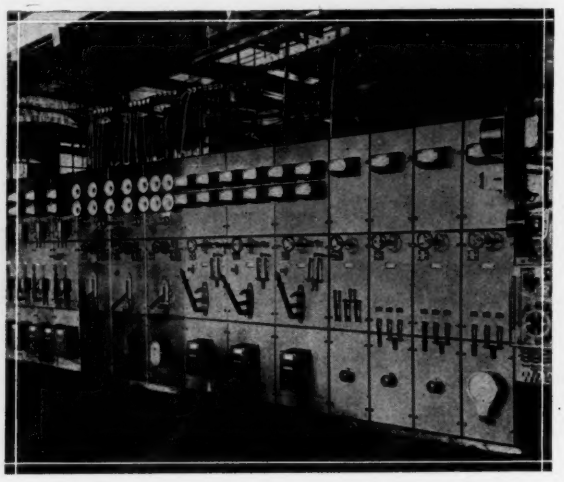


FIG. 2. ALTERNATING CURRENT SWITCHBOARD WITH EXCITER GENERATOR, MOTOR AND FEEDER PANELS

While the older development of small water powers are still utilized, at favorable points larger developments are going in which will supply to many of the towns around, which were located in the early days in the center of a group of manufacturing towns, each of which can use a considerable amount of power, and none of which are located so that they can get adequate power from streams.

The plant proper is on the Quaboag River, at Blanchardville, a short distance from Palmer, where, for some time, a steam plant and some old style water wheels have been installed, all these being connected to a shaft drive by rope transmission, and furnishing current to interurban street railways and the nearest towns. Some months ago, the Central Massachusetts Power Co. was formed, for the purpose of taking over this property and remodeling it, so that the greatest usefulness might be had from it.

The Hydraulic Plant

IN the plans for rebuilding, the first care was to utilize to best advantage the foot-pounds flowing by in the river, and for this purpose, 3 400-hp. Hercules water wheels with swing gates were installed by the Holyoke Machine Co. These wheels are of twin horizontal type, 42 in. in diameter, and operate under 14-ft. head, 9 ft. being pressure head and 5 ft. being the suction from the draft tubes. The dam was reinforced and rebuilt to get all the head possible, and the tail race was excavated to get free run off for the trail

FIG. 3. SUBSTATION FOR 22,000 TO 2300-VOLT TRANSFORMATION, AND TYPES OF POLES USED

water. The dam as it now stands is 120 ft. long, of concrete, with the power house located at one end. Leading directly into the wheel casings, are the head gates while the draft tubes, extending downward, discharge beneath the power house floor.

Direct driven by each water wheel is a General Electric, 375-kw., alternating-current generator, delivering 3-phase current at 2300 volts, and running at 150 r.p.m. The wheels are controlled by Lombard hydraulic governors of the latest type. Each one has a 20-kw. exciter belted to it, furnishing direct current at 125 volts, and running at 700 r.p.m. One of these units is shown in Fig. 2.

Where the Current Goes

FROM the generators, current is taken to the alternating current switchboard; thence it is led to 3 300-kva., oil-cooled transformers, which step the voltage up to 22,000, for transmission to distant towns. For local distribution, the current is carried at 2300 volts, to the pole transformers.

In the map of the general transmission system, Fig. 1, it will be noted the transmission lines run from the power plant to Wilbraham, to Warren, to Ware, and to Brookfield, where they enter substations. These lines are the 22,000-volt, high-tension lines, and at the substations the voltage is stepped down to 2300, after which it is sent on for distribution locally. For the towns of Palmer and Thorndike, the current is carried from the power house direct at 2300 volts.

Coming into the substation at Ware, is a transmission line labeled "Connecticut Power System." This is a line at 66,000 volts, from the Mt. Vernon plant of the Connecticut River Power Co., and is used to furnish to the Ware substation current to help out the Palmer station at times of heavy load. The current at the Ware station is stepped down from 66,000 to 22,000, and fed into the lines of the Central Massachusetts Electric Co. in parallel with the Palmer station. Figure 3 shows one of the substations for transforming from 22,000 to 2300 volts, and it will be noted that the pole lines used for the 22,000-volt transmission are wood poles and cross arms with high-

FIG. 4. WARE, MASS., HIGH-VOLTAGE TRANSFORMER AND SWITCHING STATION

tension insulators. Figure 4 shows the Ware substation, which contains the low-voltage transformers and the switching system, the high-voltage transformers being located outdoors.

Steam to Help Out

LIKE all New England streams, the Quaboag River is a creature of moods ranging from a heavy flood in the spring to extreme low water at times during the summer months. It is, therefore, necessary to supplement the power of the stream with efforts of a steam driven generator, and for this purpose, there has recently been installed, a 1250-kva. Westinghouse turbine generator unit, which operates at 2300 volts direct, 60 cycles at 3600 r.p.m., giving 315 amp. per terminal. The leads run to the same switchboard as the water-wheel generators, and may be run in parallel with them.

A considerable part of the steam load is at present the interurban street railways, which have been built to tie together all the towns in Central Massachusetts. For this service, current is needed at 625 volts, and is

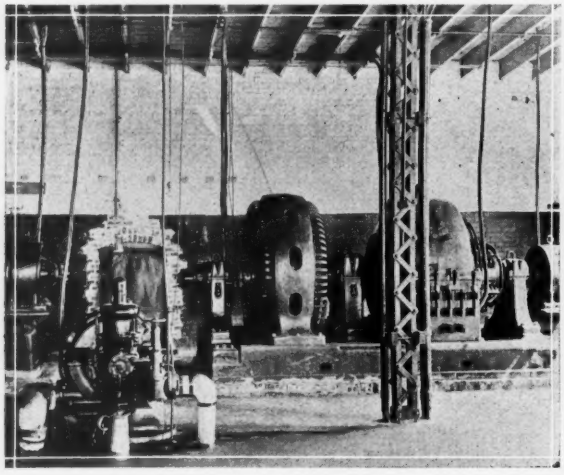


FIG. 5. 2300-VOLT A.C. TO 625-VOLT D.C. MOTOR-GENERATOR SET AND TURBINE DRIVEN EXCITER FOR TURBO-GENERATOR UNIT

obtained by the use of 2 motor-generator sets consisting of 3-phase synchronous motors with rotating field connected to 500-kw. Westinghouse generators, which feed to the direct-current switchboard. Figure 5 shows one of these units, also the small steam turbine driven exciter unit which furnishes current for the field of the big steam turbine unit. This last is a Westinghouse machine of 25-kw. capacity and is so arranged

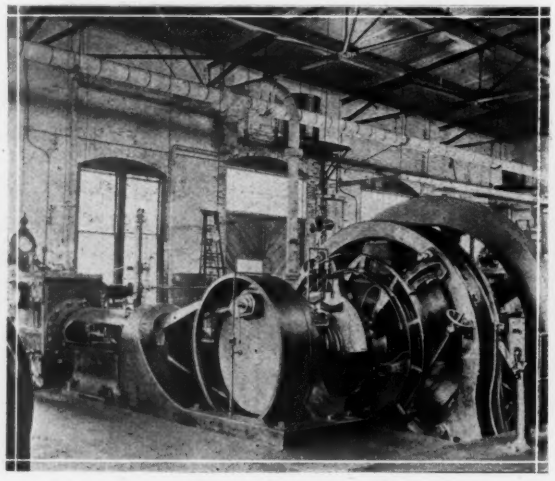


FIG. 6. ONE OF THE CORLISS ENGINES DRIVING D.C. GENERATOR. SHOWING PIPING ARRANGEMENT, COCHRANE SEPARATOR, AND OVERHEAD TANK FOR CENTRAL OILING SYSTEM

that it can work interchangeably in furnishing current with the exciters for the water-wheel units.

As machines for emergency use there are 3 Corliss engine units which drive direct-current generators; the first being a Hooven, Owens, Rentschler engine, driving direct a 225-kw. General Electric generator, which furnishes current at 625 volts; No. 2 is a Bass Foundry Co.'s engine, driving a 425-kw. General Electric generator, and No. 3 is a Slater engine, belted to a 500-kw. Westinghouse generator, through a part of the shaft which formerly tied in with the old water wheels. All these units are operated with condensers,

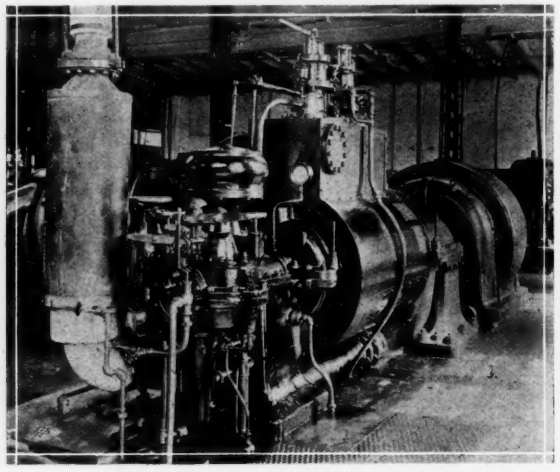


FIG. 5A. WESTINGHOUSE 1250-KV.A. TURBO-GENERATOR SET, WITH DIRECT STEAM SEPARATOR

that for the No. 1 unit being a Worthington duplex jet, for No. 2 a Bulkley injector, and for No. 3 a Warren jet, water for all of them coming from the flume at 4 lb. pressure.

Steam for operating the plant comes from a boiler house separated by a narrow alley. In this boiler house are 2 Babcock & Wilcox boilers of the Aultman & Taylor type, of 256 hp. each, which are often run up to 428 hp. each, and one Heine boiler which is rated

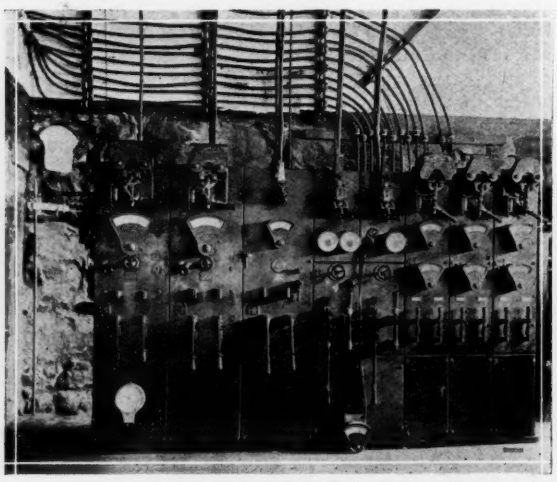


FIG. 8. DIRECT-CURRENT SWITCHBOARD CONTROLLING CURRENT FROM 3 ENGINE DRIVEN GENERATORS, 2 MOTOR-DRIVEN GENERATORS AND TO 6 FEEDERS

at 304 hp. These generate steam at 115 lb., which is supplied to the engine units through Cochrane separators, and in case of emergency, is shut off by Monarch engine stops.

For the turbine unit, the steam inlet is through a Direct separator, and is supplied at 107-lb. pressure at the nozzles of the turbine, the exhaust from that unit being into a Leblanc barometric condenser, which holds the vacuum at 28¾ in.

To serve the boilers, a stack 5 ft. in diameter by 101 ft. 6 in. in height, gives a draft of 2 in. of water at the base, which is ample for all requirements.

Feed water for the boilers is drawn either from the flume or from a hot well which takes the discharge from the condensers. The pumps for this purpose are

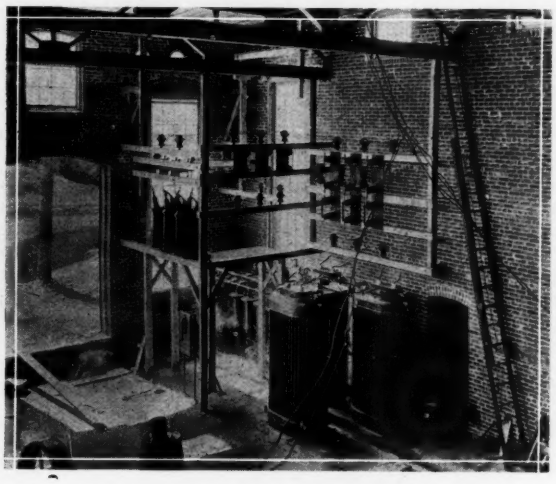


FIG. 7. 22,000-VOLT SWITCHING SYSTEM

3 in number, one a Deane of Holyoke, and the other 2 made by the Warren Pump Co. Feed water is heated first in an exhaust steam primary heater, in the basement of the engine room, and then in a secondary exhaust heater, which takes the steam from the exhaust of the auxiliaries.

Switching Control

REFERENCE has been made to the general scheme of power supply from the station, and it is evident that for such a system, a considerable switchboard equipment is necessary. As shown on Fig. 1, the

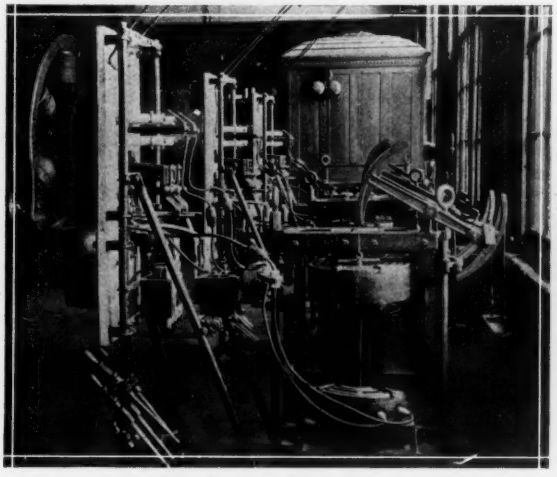


FIG. 9. TUB TRANSFORMERS AND ARC LIGHT SYSTEM CONTROL PANELS

22,000-volt line from the Ware substation leads through the Blanchardville power station, and on to Wilbraham, and the arrangement of the high-tension lines, disconnecting switches, etc., is shown in Fig. 7. The high-tension lines are provided with oil break and disconnecting switches, with choke coils and aluminum lightning arresters, all of General Electric make. This apparatus is located in one corner of the water-wheel generator room.

The switchboards proper are located on the main floor of the station and are 3 in number. The main switchboard, which is shown in Fig. 3, is for a.c. generators, the motors of the motor-generator sets, and the exciter control for the alternating-current generators.

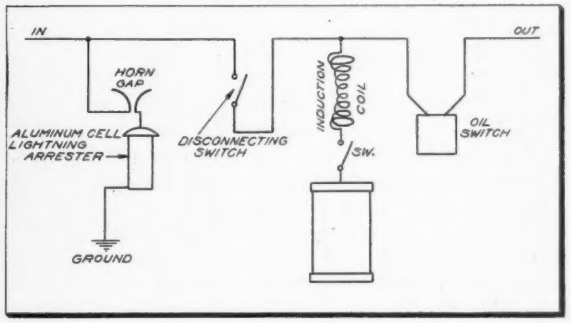


FIG. 7A. DIAGRAM OF CONNECTIONS OF LINES, TRANSFORMERS, SWITCHES AND LIGHTNING ARRESTERS

The first 4 panels are for the exciter units, 3 for water wheels and one for the steam turbine. Then come the 3 generator panels for the water-wheel units, one panel for the steam turbine unit, and 2 panels for the motors of the motor-generator sets. Beyond are 4 feeder panels, for controlling the 2300-volt transmission lines, to Bondsville, Palmer, Thorndike and Monson. On swinging arms, at the near end of the switchboard, are voltmeters, power factor meter, synchroscope, and other apparatus, and also a Tirrell voltage regulator. Rheostats for the exciter units are mounted on the back of the panels, and for the generator units are mounted upon the switchboard, as can be seen at the top of Fig. 3.

For controlling the current to the street railways, a direct-current switchboard is installed, seen in Fig. 8. This has 3 generator panels for controlling the current from the engine-driven generators, 2 panels for handling the direct current from the motor-generator sets,

FIG. 10. OUTFIT USED TO SUPPLY POWER FOR ICE HARVESTING. THE COUNTER SHAFT WAS USED TO GET PROPER SPEED REDUCTION

and 6 feeder lines for supplying current to different feeders running out along the road. The usual equipment of switches, feeders, rheostats, circuit breakers and wattmeters is provided.

One other form of service is rendered by the plant, namely, the supply of arc light street lighting systems to the towns of Thorndike, Monson and Palmer. To control these circuits, a series of panels is installed at one side of the switch room, consisting of tub transformers, for changing the constant voltage alternating current of 6.6 amp. Each unit has a capacity of 15 kw., taking current at 2200-volt on the primary side of the transformer, and supplying whatever voltage may be necessary to keep the current constant on the secondary. A rear view of these panels and a side view of the tub transformers is seen in Fig. 9.

The Use of It

SOME idea of the variety of industries supplied may be gained from the fact that at Wheelwright is a large paper mill, at Gilbertsville and Ware are large textile industries, at Brookfield and Spencer large shoe shops are in operation, in Warren, Palmer, and Monson are iron working plants, at Ludlow, a large valve factory, and in Monson, Wilbraham and East Long Meadow are granite quarries. Another feature of power supply which has been introduced is that for harvesting natural ice in the winter season. For this purpose, a portable outfit is in use consisting of a transformer stepping down from 2300 volts to 550 volts, and supplying a 20-hp., 3-phase motor, which is belted to the ice harvesting machinery. This outfit has been taken from pond to pond, and is found much more convenient and economical than the old small steam plant which was formerly in use.

Ample records of plant performance are kept, and in this process voltage is recorded by a Bristol recording voltmeter, the steam pressure by Crosby recording steam gages, and output on various lines by General Electric indicating wattmeters. That the service has been a success is proved by the fact that the connected power load has grown in one year from 27 hp. to 2600 hp., and the possibilities are seen from the fact that there is 18,000 hp. of available load in sight. This success is due to the wise planning and the efficient management of those in charge, H. M. Parsons being the general manager in control of the business and operating end of the enterprise, as well as all installation at the plant, and G. F. Parsons, the power engineer, in charge of the power department of this and allied companies.

SUPERHEATING AND SUPERHEATERS

Foreign Practice Has Proved Practicability and Economy

By Sterling H. Bunnell

MUCH thought and attention have been given to the relative advantages of engines with different types of cylinder and valve gear, whether piston valve, flat valve or Corliss. But as the difference in economy of the various types of simple engines amounts to a few per cent at most, it is surprising that so little has been done by American engineers to avoid the much larger loss from steam condensing in pipes and engine cylinders. Here is a loss amounting to 30 per cent at least, and not infrequently reaching 75 per cent, and yet generally permitted to go on quite unnoticed.

Of the thousands of steam plants in this country, it is probable that not more than one in a hundred uses superheat. This is not because the advantages of superheat are generally unknown to engineers, nor because superheaters are new and experimental devices. It looks very much as if we in the United States have lost our readiness to adopt the latest and best devices, and have fallen into that comfortable way of being quite satisfied with the old method and unwilling to take the responsibility for anything new. We used to amuse ourselves over the conservatism of the engineers of other nations, who ordered every machine just like the last, and faithfully followed their grandfather's practice. Now, every American builder of steam plant machinery knows that it takes long continued effort to get a new device, however obviously superior to the old practice, adopted by an engineer of reputation, because consulting engineers would rather play the old safe game of copying the successes of 20 yr. ago, than take the slightest responsibility for changes in their practice which would give better results.

Superheating is one of the simplest improvements in steam plant practice. It amounts to nothing more than heating the steam once formed, so far above the boiling point that it cannot condense on its way through pipes, engines or turbines. Steam in contact with water is known to transmit its heat readily to the walls of pipes or cylinders, and to condense rapidly in consequence. The slightest degree of superheat puts steam in a condition where its rate of losing heat to pipe and cylinder walls becomes extremely small. In this condition steam can be carried through pipe lines with small loss by condensation. Every engineer knows that an engine, if placed at a great distance from the boiler gets a large quantity of water along with the steam, and must be protected from accident by a good separator. In order to get each of several engines supplied by a short steam pipe, boiler plants are sometimes scattered through a large works, requiring extra firemen, coal bunkers and other accessories. All such extras are entirely unnecessary; a single efficient boiler plant with a steam superheater furnishing steam heated considerably above its condensing temperature would supply the engines with perfectly dry steam even through long lines of pipe. At least part of the heat put into the superheater would be otherwise wasted in the flue gases, so that economy would be promoted.

Even a very ordinary slide-valve engine will stand some superheat without any change in the oil or packing. This being the case, there is no reason why the superheating should not be carried a little higher than just enough to deliver the steam to the engine cylinder in dry condition. If the steam entering the cylinder is superheated, condensation on the cylinder walls previously cooled during the exhaust, is prevented. A moderate degree of superheat will increase the economy of any engine considerably. The temperature of the steam can be increased without trouble in the engine, if the piston and valve rods are provided with metallic packing, and good cylinder oil is used. The maximum degree of superheat desirable with any engine can be easily determined by trial.

There is another large field for superheat, not connected with any engine. Every manufacturing plant using large quantities of steam for heating liquids, cooking, drying, dye-house work, vulcanizing, and the like, suffers large losses of steam by condensation in

the pipe lines leading to the various heating devices. Saturated steam is best for heating, since the steam is wanted in condition to condense and give up its stored latent heat. But there is no reason why the steam should not be brought to the heating pipes without condensing and so losing heat on the way. This object can be attained by superheating the steam sufficiently so that its loss of heat in passing through the main pipes will bring it to just about condensing temperature by the time it reaches the points where it is to be used. It is no uncommon condition to lose half the steam supplied by the boiler, in condensation along the pipe lines. All of this condensation loss can be avoided, at the cost of the trifling amount of heat needed to superheat the steam. The reason for the decreased rate of condensation is not because the steam in the pipes is hotter, but because it is not in condition to condense partially at the slightest loss of heat, and so passes through the pipes in dry condition, transmitting heat to the walls of the pipe with difficulty.

The apparatus required for superheating is of the simplest. It consists, in general, of steel tubes projecting into a suitable chamber or flue in the boiler setting. Being subjected to high temperature, the tubes are best of seamless drawn material. The tubes are secured to suitable headers by flanged joints with metallic or asbestos gaskets. Extended surface in contact with the flue gases is secured in some types of superheater, by disks or washers of iron strung on the tubes, with the intention of assisting the absorption of heat from the flue gases. Plain tubes, however, present less opportunity for collection of ashes, soot and dust, and are preferred by other makers for this reason. One type of superheater in extensive use in England and Scotland has all joints between tubes and headers made exterior to the superheater setting.

With all superheaters, the steam is taken from the steam dome or dry pipe of the boiler to one of the superheater headers, passed through the superheater tubes, and out by the header at the opposite end. A trifle of water is sure to pass to the superheater with the steam, and unless efficiently interrupted in the first header, will evaporate in the tubes and in time leave a deposit of solid matter, sometimes to such an extent as to cause a tube to become overheated and give way. Little harm is done by a burnt tube, as there is no body of water in the superheater behind the steam, to boil explosively and cause general destruction. It is only necessary to close the 2 valves in the superheater's main connections, and open a bypass valve to admit the steam to the main without superheat until the damaged tube can be replaced. A tube failure in a properly designed superheater is rare indeed.

The amount of superheat is usually regulated once for all by installing a proper amount of tube surface to insure sufficient superheating, and removing a tube or two if the superheat is found to be higher than needed for best results. There is generally no trouble by variation in temperature of steam.

Superheaters may be installed in openings provided in boiler settings, so that each boiler has its own superheater; or in separate settings with independent fires. With an existing boiler plant supplying saturated steam, a single independent superheater and furnace may be installed without disturbing the existing arrangement. The small amount of coal necessary for firing the superheater will be only a fraction of the quantity saved in the furnaces of the boilers after superheating is performed and the previous large losses by condensation are eliminated.

FLANGES AND FLANGE FITTINGS

American Standard

THE use of flanges and flange fittings has been increasing quite rapidly of late years, in fact, a flange joint is the standard form of connection in many classes of piping. For most purposes the ordinary screw connection should not be used above 6-in. pipe size on account of the difficulty of making and breaking joints.

As the flange fitting business grew, each manufacturer made up patterns for whatever sizes were called for, to his own personal ideas or knowledge at that time.

These dimensions were later published in catalogs and a wide variation in dimensions was found.

The variation in the diameter and thickness of flanges as well as the bolt circle, size and number of bolts on standard weight material caused the users and manufacturers considerable confusion and expense.

This brought about the movement by the American Society of Mechanical Engineers and the Master Steam & Hot Water Fitters Association, assisted by the manufacturers of these lines, the result of which was the adoption of what is known as the A. S. M. E. Standard of 1894. This covered flange dimensions and bolting only.

A few years later the manufacturers began to realize that the extra heavy 250-lb. flanges and bolting were in the same state of confusion. This resulted in the adoption of what has been known as the Manufacturers' Standard of 1901.

It became evident in the past few years that the center to face and face to face dimensions of all flange fittings, including low pressure, standard pressure and extra heavy pressure, should be established. After considerable work on the part of the M. S. & H. W. F. A. and the A. S. M. E. a standard known as the 1912 U. S. Standard was adopted.

The adoption of this standard opened a discussion among those interested in the subject. It was found that the dimensions presented in 1912 U. S. Standard different from the dimensions which had been quite universally used by manufacturers and which covered a large majority of the fittings made.

At a meeting of manufacturers held in New York City, July, 1912, a standard known as the Manufacturer's Standard was adopted by them.

This left the flange fitting subject in the unfortunate position of there being 2 standards. When this condition came before the Committee of the A. S. M. E. an effort was made by this Committee with that of the Manufacturer's Committee to harmonize, if possible, the differences then existing between these 2 standards.

After considering the various phases of the subject covering uniformity of design, strength of fitting, strength of bolting as well as the commercial features, a compromise was made.

In this compromise the bolting was increased where it was thought necessary. Additional size flanges were added and the center to face and face to face dimensions were altered to conform to these requirements.

In the Practical Reference Tables of this issue will be found some of the Standard dimensions adopted together with explanatory notes, other dimensions will be published in the Reference Tables of succeeding issues.

HEATING AND VENTILATING LARGE BUILDINGS

Types of Fans, Capacity and Power Required

By Charles L. Hubbard

COMMON use of ventilating fans in large structures like office buildings, dry goods stores, public buildings, etc., makes it necessary for the engineer in charge to have at hand in condensed form a certain amount of practical data relating to apparatus of this kind.

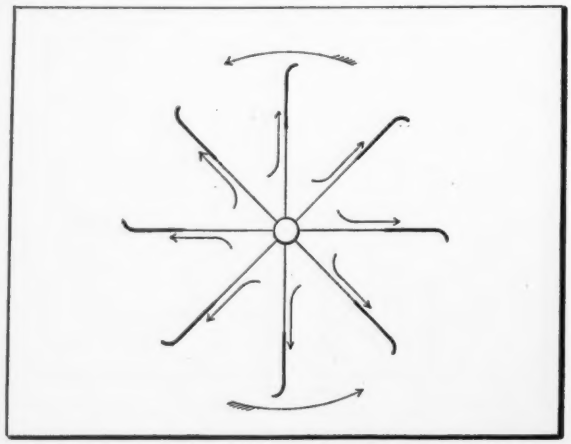


FIG. 1. CENTRIFUGAL OR PADDLE WHEEL FAN

Ventilating fans are of 2 general types, the centrifugal and propellor. The centrifugal or paddle wheel fan is more commonly used for forcing fresh air into a building on account of its greater power in overcoming the frictional resistance of the ducts. This fan consists of a number of straight or slightly curved blades extending radially from an axis, as shown in diagram in Fig. 1.

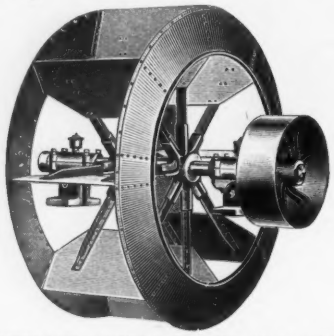


FIG. 2. STURTEVANT DOUBLE SPIDER FAN WITH STRAIGHT BLADES

When the fan is in motion the air in contact with the blades is thrown outward by the action of centrifugal force and delivered at the tips of the blades, as indicated by the arrows in the cut.

An unmounted fan wheel in practical form is shown in Fig. 2, which represents a double spider fan with straight blades. Those over 4 ft. in diameter usually have 2 spiders, while larger ones are provided with 3 or more, according to their size. The number of floats or blades usually varies from 6 to 12 according to the diameter. In some styles a curved form is given to the blades in order to make them run more quietly, but if curved too much they are not so efficient in working against a high pressure.

General proportions vary somewhat in different makes, but the following represent a fair average. Total width of wheel = 0.5 of diameter; width at tip of blade = 0.8 of total width; diameter of opening inside of wheel = 0.68 of total diameter. Fans of this kind require a steel plate casing to direct the flow of the air, these are constructed both with single and uble inlets, the former being called exhausters and the latter blowers, although used indiscriminately for both purposes.

In general, however, for the larger sizes, it is better to use the double inlet fan for both purposes, as it reduces the friction somewhat, although a single inlet of ample size will give satisfactory results when the double inlet type cannot be used to advantage. Fan casings are made to order with the discharge outlet in any position desired so as to throw the air either up or down, horizontally, or at any angle.

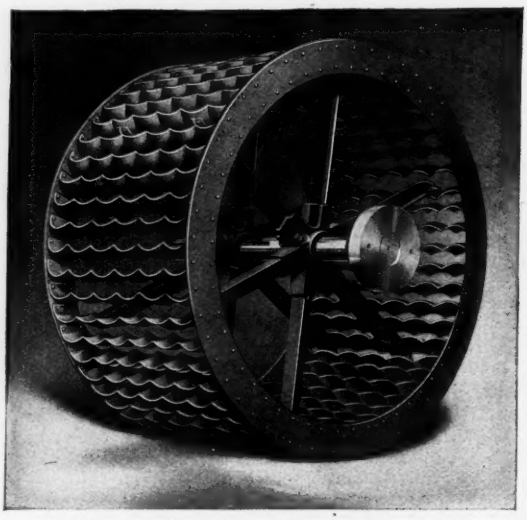


FIG. 3. RUNNER OF A MULTIVANE FAN

When the basement is low, and especially if the air is to be distributed through underground ducts, the three-quarter housing type is used. In this case about a fourth of the casing is below the floor level and is formed by a cement pit conforming to the scroll of the fan.

The size of a fan is expressed in 2 ways. When given in feet, it means the diameter of the fan wheel; but when given in inches the height of the casing of a full housed fan is meant.

As a matter of fact, the relations are such in most makes, that the diameter in feet may be found by dividing the height in inches by 20. For example—a 140-in. fan has a wheel $140 \div 20 = 7$ ft. in diameter; or a 7-ft. wheel has a casing $7 \times 20 = 140$ in. in height.

Another type of fan wheel made by the B. F. Sturtevant Co., which has come into quite general use, is a centrifugal fan, known as the multivane, and has a large number of narrow blades, spoon-shaped, so as to discharge the air evenly the entire length. These fans are smaller and lighter for a given capacity, and run at a higher speed.

The cone fan shown in Fig. 4 is often employed in schools and other public buildings, where a large volume of air is required under a low pressure and where there is ample space. This fan requires no steel casing, being set in an opening in a brick wall, and discharges the air from its entire periphery into a room called a plenum chamber, with which the various distributing ducts connect.

A common form of disk or propeller fan is shown in Fig. 5. This operates on the same principle as the propeller of a boat and moves the air in lines parallel with the shaft.

This fan is light in construction, requires but little power at low speeds, and is used extensively for the ventilation of public toilet-rooms, smoking rooms, restaurants, etc. It is also adapted to the discharge ventilation of large rooms or halls when placed in the attic or so located that the connecting ducts are short and the resistance small.

Capacity and Power

THE capacity of a centrifugal fan varies with the speed, the resistance against which it operates, and of course, with the size. While part of these are easily fixed, it is not a simple matter to determine beforehand what the frictional resistance will be. For this reason, there is little use in making exact and complicated computations for a part of the work when the remainder must be approximated. In practice it is customary to determine the size and capacity as nearly as possible, and then vary the speed a small

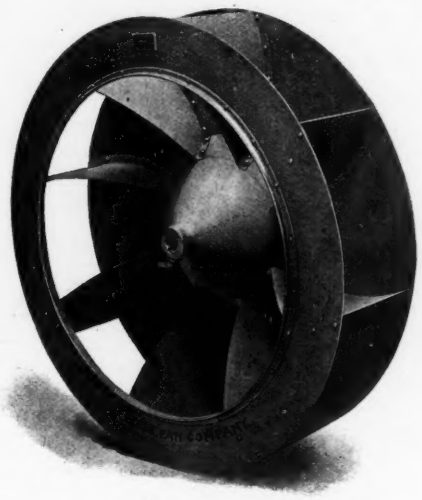


FIG. 4. CONE FAN UNMOUNTED

amount one way or the other to obtain the exact results desired. For ordinary work the following equation may be used with a sufficient degree of accuracy.

$$V = 0.65 \times C \times R \times O \times F,$$

in which,

V = volume of air moved, in cubic feet per minute.

C = circumference of fan wheel, in feet.

R = Revolutions per minute.

O = area of discharge outlet, from fan casing, in square feet.

F = a factor depending upon the frictional resistance in the ducts, which may be taken as 0.8 for schools and churches; 0.7 for office buildings and dry goods stores; and 0.6 for shops and factories.

The factor F does not of course depend upon the use of the building, but upon the air velocities, lengths of run, etc., commonly found in the ducts of these particular types of building.

For cases where noise is objectionable, as in schools, churches, etc., the peripheral velocity ($C \times R$) should not exceed about 3500, while for shops and factories it may run up to 5500 or more. The capacity of any given fan may be determined approximately by the above formula for the conditions under which it is to be run.

In computing size of a new fan to move a given volume of air we must first assume a given size, as nearly as we can estimate it, give it a speed just inside the limit noted, also using the factor F for the kind of building under consideration, and solve for the

FIG. 5. COMMON FORM OF DISK FAN

capacity. Use this result, as a guide, and make other trials, shifting diameter and speed until the desired capacity is obtained. A little practice will enable one to do this very quickly, and it is also a good idea to work out a table of capacities for different diameters of fans running at the speeds best adapted to any particular kind of building in which the engineer is especially interested.

The following table gives the circumferences of fans of different diameters and also the approximate area of outlet, and is for use with the formula already given.

TABLE I. FAN DIMENSIONS

Dia. of fan (D) feet	Circumference (C) feet	Outlet Area (O) square feet
3	9.4	2.9
3½	11.0	3.9
4	12.5	5.0
4½	14.1	6.2
5	15.7	7.6
5½	17.3	9.1
6	18.8	10.7
7	22.0	14.4
8	25.1	18.6
9	28.3	23.4
10	31.4	28.7

The power required for moving a given volume of air varies with the speed of the fan. For example, the power per cubic foot is considerably more with a fan running at 300 r.p.m. than at 200 r.p.m. Table II gives the horsepower for driving fans of different sizes at different speeds when discharging into the free air. For practical work, multiply the numbers found in the table by the following factors. Schools and churches, 0.9; office and store building, 0.8; shops and factories 0.7.

When the speed comes between those included in the table, take the average of the next higher and next lower, repeating the process until the result is found for a speed within 5 or 10 revolutions of that required.

TABLE II. POWER REQUIRED FOR FANS

Dia. of Fan	Revolutions Per Minute						
	100	150	200	250	300	350	400
	Horsepower Factor						
3′				1.0	1.4	2.0	2.6
3½′			1.1	1.8	2.6	3.7	4.3
4′			1.7	3.1	4.5	6.0	8.0
4½′		1.7	3.1	5.0	7.0	9.7	13.1
5′		2.6	4.8	7.1	10.6	14.4	
5½′	1.6	3.7	6.6	10.3	16.2		
6′	2.2	5.2	9.5	15.0	22.7		
7′	4.3	9.7	17.4	28.1			
8′	5.2	16.5	30.2				
9′	11.5	26.4	50.0				
10′	17.9	40.2					

Example. A certain office building requires a 7-ft. fan running at 180 r.p.m. to furnish the necessary amount of air. What horsepower of motor will be required to drive it? Looking in the table for a 7-ft. fan we find the factors for 150 and 200 r.p.m. to be 9.7 and 17.4 respectively, which gives $\frac{9.7 + 17.4}{2} = 13.5$ for 175 r.p.m., which is within 5 revolutions of that required. Multiplying this by 0.8, the factor for office buildings, gives $13.5 \times 0.8 = 10.8$, or 11 hp. in round numbers, required.

As the capacity of a disk fan and the power for driving it vary so widely with the resistance to be overcome, it is difficult to give definite rules for determining them. For average conditions, the data found in Table III will be found useful.

TABLE III. CAPACITY OF DISK FANS

Dia. of Fan Inches	Cubic feet of air moved per rev.	Speed limits in r. p. m. for best results
24	4.4	550 to 850
30	8.6	450 " 650
36	15.0	400 " 600
42	23	350 " 500
48	35	300 " 400
54	50	250 " 350
60	68	225 " 325
72	119	200 " 300
84	187	175 " 250
96	280	150 " 225

The power will of course vary with the resistance and speed of fan, but for the conditions assumed above, may be taken as 0.2 hp. per 1000 cu. ft. of air moved per minute.

Means for Driving Fans

STEAM engines and turbines and electric motors are the means most commonly employed for driving ventilating fans. While motors are almost universally used in large buildings having their own electric plant there are still cases where an engine drive is the most desirable. This might apply to instances where electric current was purchased at a high price, or where it was desired to vary the speed of the fan within wide limits, especially where an alternating current was used.

Engines may be either vertical or horizontal, direct-connected or belted. When direct-connected any looseness or knocking in the engine is likely to be communicated to the fan and the noise carried to the rooms above, but this arrangement is more compact. When belted, the distance between fan and engine centers may be from 8 to 12 ft. according to size, and the driving side of the belt should be at the bottom when possible, in order to increase the arc of contact.

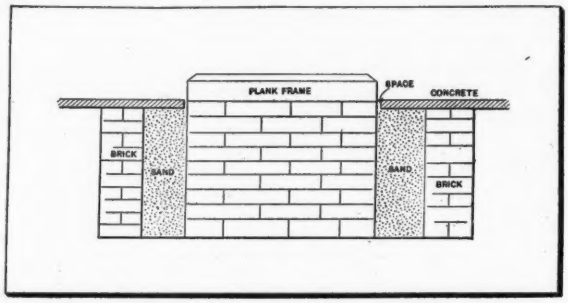


FIG. 6. SPECIAL FAN FOUNDATION

The multivane fan driven by a direct-connected steam turbine makes a simple and quiet running outfit.

Electric motors, especially when direct-connected to the fan, are the most convenient and compact, and are widely used in combined power and heating plants. The direct-current machines are much to be preferred, not only because the speed is more easily regulated, but also on account of the slower speed, which makes it possible to connect them directly to the fan shaft by means of a flexible coupling.

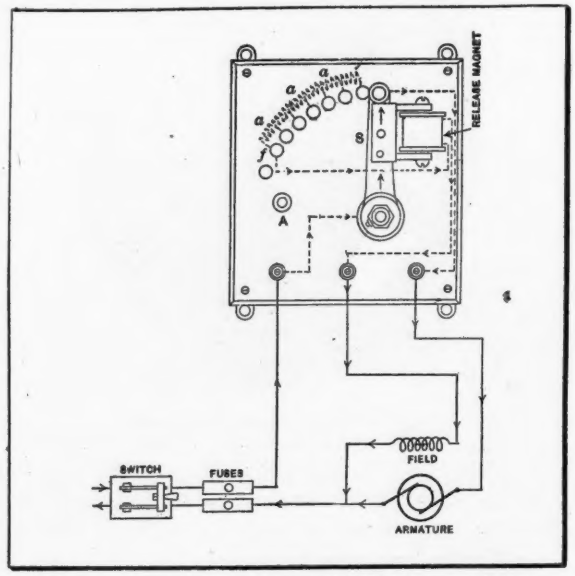


FIG. 7. CONNECTIONS FOR DIRECT-CURRENT MOTOR

In case of the smaller sizes the motor may be supported from the fan casing, but in large outfits it is best to use a double-inlet fan and mount the motor upon a special foundation about 2 ft. or so from it and connect the 2 shafts by means of a flexible coupling. When there is danger of any vibration being transmitted from the fan or motor to the building walls the foundation may be constructed as shown in

Fig. 6, in which case the main foundation is surrounded by a trench filled with sand, closely packed while moist, and outside of this a brick or concrete wall as shown.

The method of making the wiring connections with a direct-current motor is shown in Fig. 7, the outfit containing switch, fuses, and starting rheostat. When it is desired to vary the speed of the fan, a regulating rheostat of the general form shown in Fig. 8 should be substituted for the starting rheostat. For small motors, under 10 or 15 hp., the rheostats used commonly operate by varying the armature resistance, although this is a somewhat wasteful method.

The type shown in Fig. 8 combines armature and field variation in the same rheostat. Moving the lever toward the right increases the speed of the motor by first cutting out the resistance in the armature circuit. A further movement of the lever throws an increasing resistance into the field circuit, thus weakening it and causing the speed to increase still more.

The continuous use of rheostats for speed regulation should be avoided when possible, but for a temporary reduction of speed of a few hours, from time to time, they may be employed without serious waste.

For a permanent cutting down of the air supply it is better to change the speed of the motor or throttle the main air duct beyond the fan, which can be done without waste of energy with a fan of the centrifugal type.

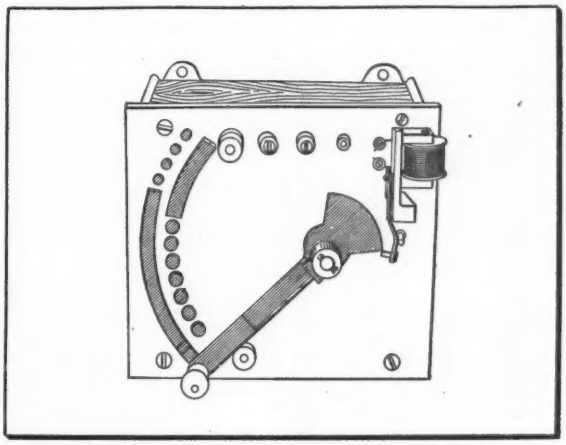


FIG. 8. SPEED REGULATING RHEOSTAT

CURTIS STEAM TURBINES

Efficient Turbo-generators in Small Units Available for the Isolated Power Plant

CURTIS steam turbines of from 100 to 2500 kw. capacity have been developed by the General Electric Co. for driving 60-cycle generators at 3600 r.p.m. The performance of these units in regular service shows them to be well adapted for industrial and lighting plants where economy and reliability are required in generating electric power.

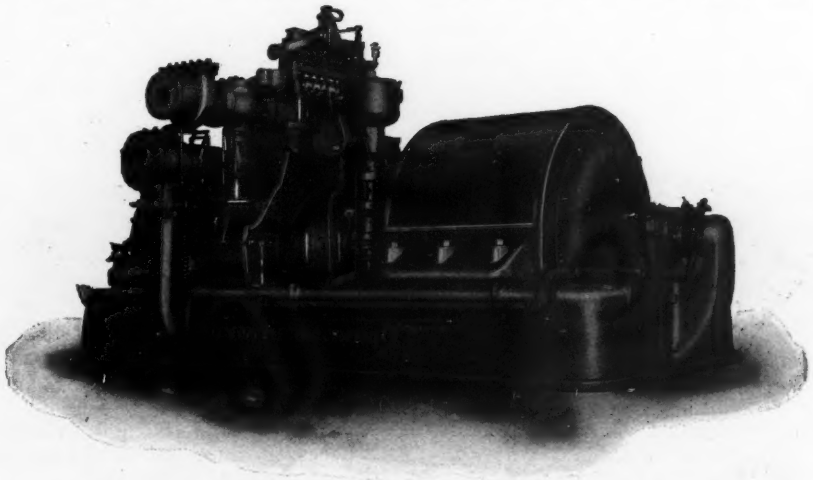


FIG. 1. 750-KW. CONDENSING CURTIS STEAM TURBINE 3600 R.P.M., 60-CYCLE

In the Curtis turbine, which is of the impulse type, the driving torque is due to the force of the impinging steam on entering and of the reaction when leaving the moving vanes. Expansion of the steam occurs entirely in the stationary nozzles.

From Fig. 2 it will be seen that the rotating part of the Curtis turbine is simple, consisting only of a steel shaft and the wheels to which are attached the vanes. A cast-iron casing enclosing the wheels, together with the bearings which support the shaft, comprise the only stationary parts of the turbine. The governor and valve mechanism are made as simple as possible with due regard to reliability and efficiency.

In turbines of from 100 to 2500 kw. capacity, it is common practice to employ either 2, 3 or 4 pressure stages. The stages, or compartments, are separated by diaphragms, Fig. 3, placed between the wheels, each stage containing a wheel and a set of nozzles for expanding and directing the steam against the revolving blades. On each wheel are mounted 2 or more rows of moving blades. When 2 rows of vanes are used as shown by Fig. 2, a single row of stationary reversing vanes or buckets is placed between the 2 rows of revolving blades for the purpose of properly directing the flow of the steam into the second row of buckets.

Steam at or near boiler pressure is admitted to the nozzles of the first stage where it expands, acquiring considerable velocity, and then passes through alternate sets of moving and fixed blades, thus giving up part of its kinetic energy. It then enters the second set of nozzles, expands, and passes through the second series of fixed and moving vanes in which more of its energy is absorbed. After leaving the last set of revolving vanes, which in this case is the second stage,

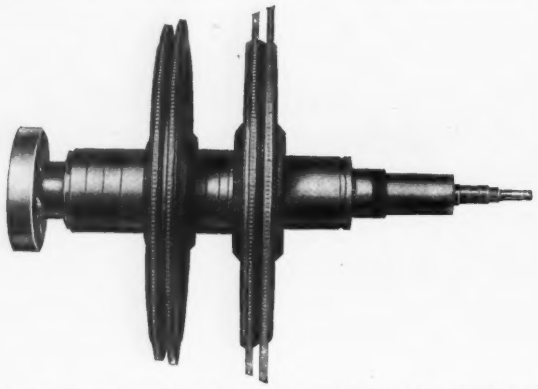


FIG. 2. ROTATING ELEMENT OF 2-STAGE 1000-KW. TURBINE

the steam is exhausted either into condenser or the atmosphere, depending upon whether the turbine is running condensing or noncondensing. As in all turbines of this type, the pressure remains constant throughout any given stage, the only drop of pressure occurring in the nozzles. In this manner the potential energy of the steam is transformed into kinetic energy, which is in turn imparted to the revolving wheels. One of the sections of the first stage nozzles of a 1000-kw. 2-stage turbine is shown in Fig. 4.

These turbines may be operated with steam at ordinary pressures condensing or noncondensing, and also are well adapted to operation with superheated steam. When running condensing, a high vacuum may be maintained indefinitely, due to the steam seal of the shaft packing and the large passages provided for the exhaust steam. On account of the steam flow being always in the same direction and at uniform temperatures, the internal condensation loss is reduced to a minimum.

The high degree of efficiency obtained with the Curtis turbine applies not only to economy in the use of steam, but includes in the cost of operation, the oil used, attendance required, and cost of repairs. Since oil is circulated through the bearings in a closed system and internal lubrication is not required, the cost of oil is small. Due to the slight attention required, and the simple but strong design, the cost of attendance and repairs is also low.

Some of the special features of construction are as follows: The wheel casing is made of the best quality of cast iron and is accurately machined, insuring tight joints and good alinement. The shaft, which is short, is of ample diameter, and the wheels attached to it are made of a high grade of steel best adapted to the purpose. The blades are made of a practically noncor-

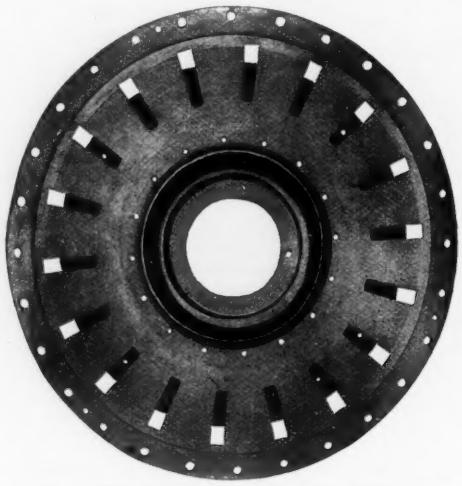


FIG. 3. HIGH-PRESSURE SIDE OF DIAPHRAGM

rosive metal of a high tensile strength, and are attached to the wheel disk by inserting dovetail extensions on the buckets into dovetail grooves on the wheel disk. The construction of these blades, which are large and few in number, is such as to provide great strength and allow an ample factor of safety.

On account of the large clearances, both axial and radial, between the rotating and stationary parts, it is possible, in an emergency, to put the machine into service without any preliminary heating up. These clearances are so large that no damage to blades is likely to occur under ordinary service conditions. Steam economy, however, is not affected by the extent of the clearances, and no further attention to this is necessary after the wheels are once placed in their proper positions on the shaft.

FIG. 4. EXIT SIDE OF FIRST STAGE NOZZLE OF 1000-KW. 2-STAGE TURBINE

The governor, which is of the centrifugal inertia type, is both positive and sensitive. It controls the admission valves through a relay, thus being relieved of having to supply the power required to actuate the valves. The steam admission valves operate in sequence and in such a way as to admit the steam without loss of pressure. Their simple construction permits of easy removal and replacement. An emergency governor independent of the speed regulating governor, operates to prevent excessive speed should the main governor fail, which is a remote possibility.

Due to the uniform turning impulse of the steam on the wheels and the flywheel effect of the rotating parts, parallel operation of generators is accomplished with ease and certainty.

Since the weight of the unit is comparatively small, on account of the absence of heavy reciprocating parts, an appreciable reduction in the cost of foundations is made possible.

Babbit lined bearings, split and spherically seated, are used, and are lubricated by oil under slight pressure, the oil being furnished by a pump driven through gearing from the turbine shaft. Oil rings are also fitted to the bearings, so that there may be sufficient lubrication when starting up or shutting down. In the small sizes the oil is air cooled, while with the larger units, the bearings and oil are cooled by the circulation of water through small copper coils imbedded in the babbit.

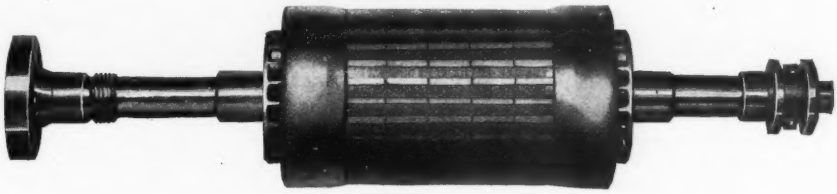


FIG. 5. REVOLVING FIELD OF 1000-KW. 3600 R.P.M. TURBO-GENERATOR

The generator is of the enclosed type, the collector rings and brushes being placed at the end farthest away from the turbine, where they are readily accessible. The armature coils, which are form wound, are inserted in slots in the punchings and held in place by wedges. Space blocks separate the end coils on the fields, and nickel steel rings are shrunk on to hold them in place, Fig. 5. Windings for any of the usual standard voltages, 2-phase or 3-phase, may be applied, and the machines can safely carry full rated kilowatt output at 80 per cent factor.

All generators are self-ventilated. In Fig. 5 may be seen the fans at both ends of the rotating field. The air, which is drawn in through ducts at either end of the machine directly under the end shields, which act as funnels, is forced through the generator, cooling the coils, and finally discharged through a large central duct.

Since a turbine requires no internal lubrication, exhaust steam from a condensing turbine may be condensed and used in making artificial ice for drinking purposes, or the steam from a noncondensing turbine may be safely used for heating and industrial purposes.

Steam may be extracted from a Curtis turbine for heating or manufacturing purposes without impairing the efficiency of the machine. In the smaller sizes, steam in moderate quantities may be extracted when the generator is fairly well loaded, the amount being regulated by a valve placed in the extraction line. The larger sizes may be equipped with an internal valve for controlling the admission of steam to the later stages of the turbine, thereby diverting the desired amount of steam to the extraction line. Such a valve may be controlled either automatically or by hand.

Through a large amount of experimental research and the experience gained in an extensive manufacture, the General Electric Co. has been enabled to reach a high degree of efficiency in the manufacture of the Curtis turbo-generator. The simple construction, careful design, and excellence of material of these machines, insure reliability in service, which should be the first requirement for generating apparatus where an industry must depend on its power plant.

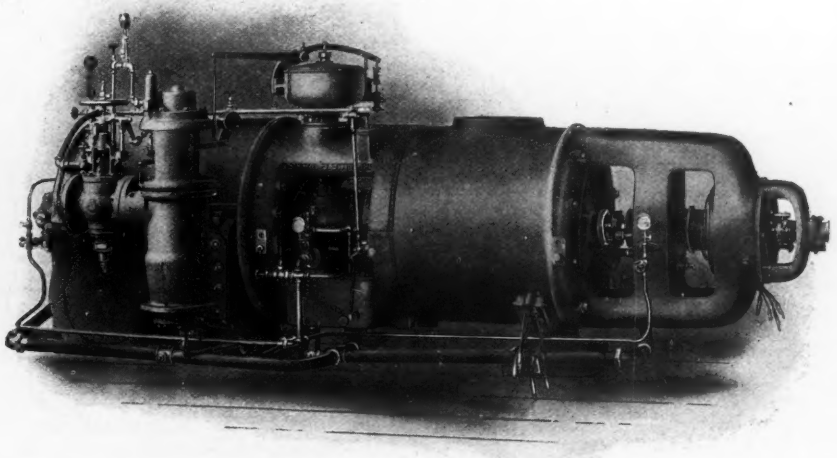


FIG. 6. 100-KW. CONDENSING OR NONCONDENSING CURTIS TURBINE, 3600-R.P.M., 60-CYCLE

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PRACTICAL ELECTRICAL ENGINEERING

General Types of Direct-Current Generators; Classification of Frames and Pole-pieces; Armature and Commutator Construction; Bearings and Winding Details

By Norman G. Meade

DIRECT-current generators are divided into 3 general forms, depending upon their mechanical construction: belted type, direct-coupled type and engine type. The former is self contained, that is, it is a complete unit with base and bearings. The direct-coupled type of generator generally includes the field frame and armature mounted on its own shaft, the bedplate and pedestal bearing being furnished by the engine builder. The rear end of the armature shaft is provided with a flange which bolts to a similar flange on the engine shaft, the commutator end of the armature shaft being supported by the pedestal bearing. Engine-type generators include the field frame and armature without a shaft; the armature is pressed on the engine shaft at the time of erecting the unit.

Belted-type generators are generally constructed with end-bells for supporting the bearings, as this construction reduces weight and makes the machine more compact. The simplest type of frame is that shown in Fig. 1, where the frame and pole pieces are cast integral as shown at A. With this form of construction, shoes or pole-pieces are sometimes attached to the poles as shown in Fig. 3, where A is the pole, B the shoe and C one of 2 or more screws for holding the shoe in position.

Such construction is principally confined to cheaper types of machines built to meet severe competition. The common type of construction employs the bolted-in poles as shown in Fig. 1 B and C. The poles may be solid wrought iron, or laminated as shown in Fig. 4. The advantage of the bolted-in pole is that material of higher permeability than cast iron or steel can be used, thus reducing the bulk and weight of the pole.

As a rule small machines have the field frame cast solid; but there are limiting conditions such as weight and shipping dimensions which require the field frame to be made in halves, generally split horizontally as shown in section in Fig. 2, where A is a flange and B the bolts for fastening the 2 parts together.

Referring again to Fig. 4 this shows the common construction of laminated or built-up pole. It is composed of a large number of sheets of iron or steel A, Fig. 5 with one projecting corner B. When assembling, these projections are placed alternately right and left so that the completed pole tips have half the volume of metal that the body has, thus increasing the flux density at the tips thereby lessening the effects of armature reaction and improving commutation.

The assembled laminations are subjected to hydraulic pressure and riveted as shown by A, Fig. 4,

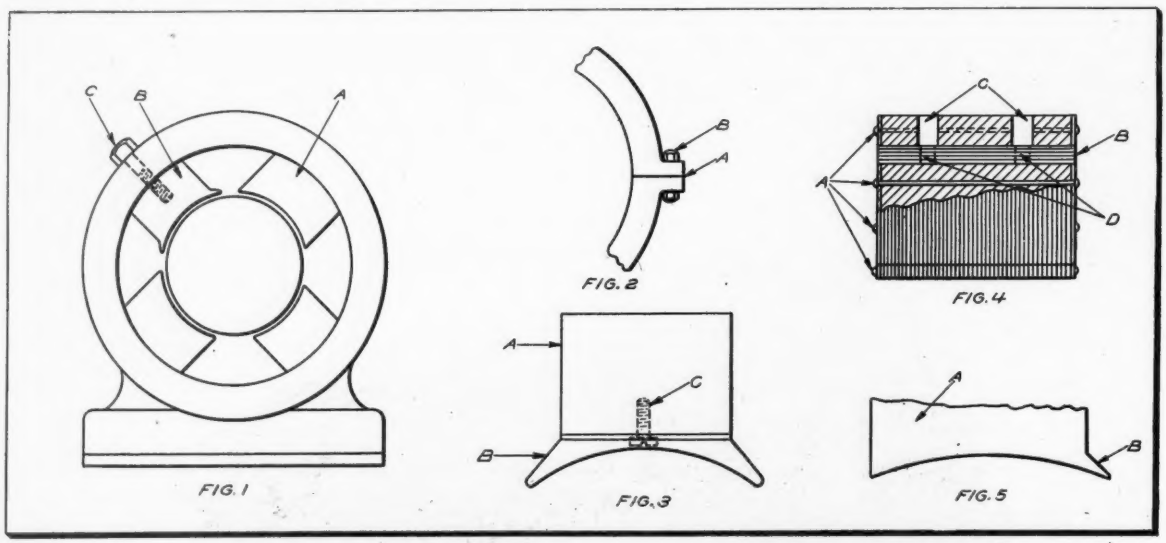


FIG. 1. SIMPLE TYPE OF GENERATOR FRAME, SHOWING CAST IN AND BOLTED POLES
FIG. 2. JOINT OF HORIZONTALLY SPLIT FIELD FRAME
FIG. 3. DETAIL OF SHOES
FIG. 4. DETAILS OF LAMINATED POLE
FIG. 5. FORM OF LAMINATED IRON FOR POLE

the 2 outside plates being thick enough to afford rigidity. A rolled steel or iron rod B is placed in a hole bored to receive it, the retaining bolts for attaching the pole to the frame, screwing into the rod at D and passing through the holes C.

Where there is little head room, it is sometimes almost impossible to erect a horizontally split frame and to meet such conditions the vertically split frame

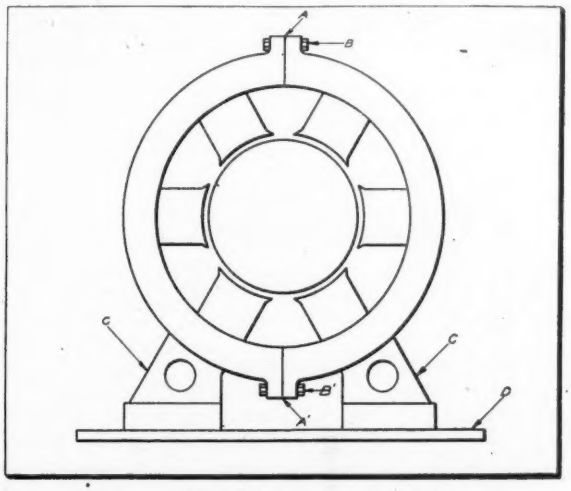


FIG. 6. VERTICALLY SPLIT FIELD FRAME

was devised. It is clamped together by bolts at B and B^1, Fig. 6, passing through the flanges A and A^1. The halves rest on feet C and C which in turn rest on rails D. When erecting a generator of this type the halves are placed one on each side of the armature, forced into position and bolted.

A new form of field construction for small machines is shown in Figs. 7, 8 and 9. It consists of a steel plate, Fig. 7, which is rolled into a circle and

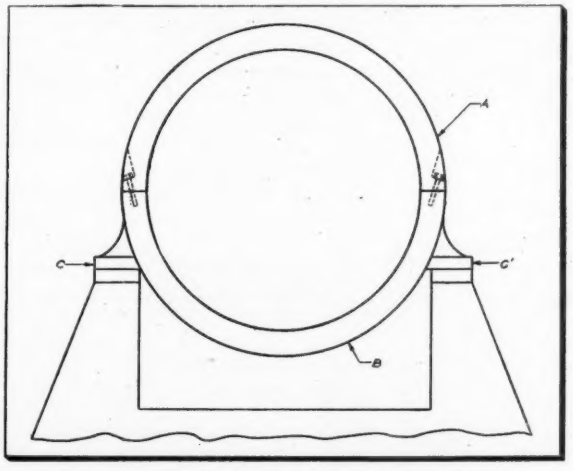


FIG. 10. FRAME OF ENGINE-TYPE GENERATOR

electrically welded at A, as indicated in Fig. 8. Four pressed-steel feet, Fig. 9, are welded to the frame to form its supporting base. The principal advantage of this construction is extreme light weight.

Engine-type generator frames are, as a rule, split horizontally, see Fig. 10; the upper half A, is bolted to the lower half B, the whole frame being supported by the feet C and C^1 well up the sides so that the lower half B extends down into the flywheel pit. In some cases the construction shown in Fig. 6 can be used to advantage for engine-type generators.

Armatures and Armature Details

ONE of the important features of armature construction is to provide as much ventilation as possible through the core and windings. The laminations are therefore built upon a spider with several air spaces

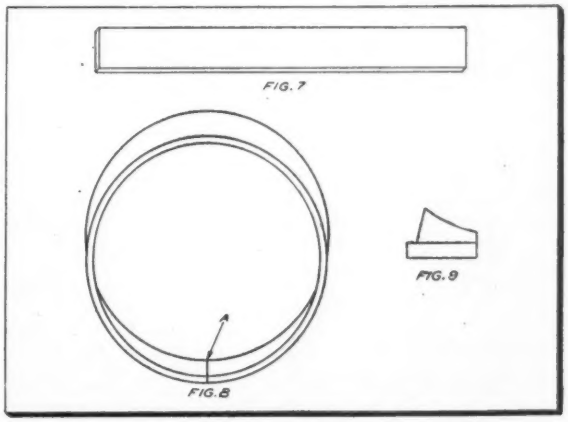


FIG. 7. STEEL PLATE USED FOR FIELD FRAME
FIG. 8. FORM OF FINISHED STEEL FIELD FRAME
FIG. 9. PRESSED STEEL GENERATOR FEET

in the core, A, Fig. 11; the air space through the center of the core is indicated by B and the separating ribs by C. The air is drawn in through the center opening B and discharged through the spaces A as indicated by the arrows. The separating ribs C are cast to a plate D, Fig. 12, these being placed at predetermined distances in the core as it is built up.

There are necessarily limitations to the size of punchings so that in large armatures, instead of con-

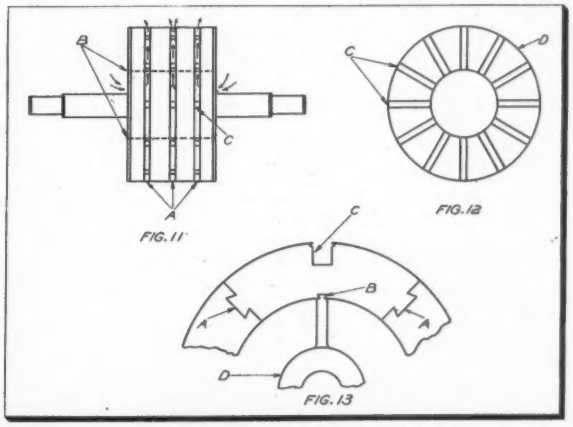


FIG. 11. CONSTRUCTION OF ARMATURE SHOWING AIR-SPACES
FIG. 12. SEPARATING RIBS USED IN ARMATURE CONSTRUCTION
FIG. 13. FORM OF LAMINATION USED IN LARGE ARMATURES

tinuous ring laminations, the ring is built up of segments shown in Fig. 13, which are dovetailed together as indicated by A, the webs of the spider cast to the hub D also dovetail into the segments as shown at B. C shows one slot for receiving the coils. The joints A are not placed one above the other, but are

staggered so that when the core is assembled it makes practically one continuous ring. The laminations are either held together by insulated bolts passing through the core or by means of end rings bolted to the spider.

Commutator Construction

FIGURE 14 shows the construction of a modern commutator for large belt-driven machines. Engine-type generators employ practically the same construction with the exception that the hub and spider are dispensed with and the commutator ring D is cast integral with the armature spider.

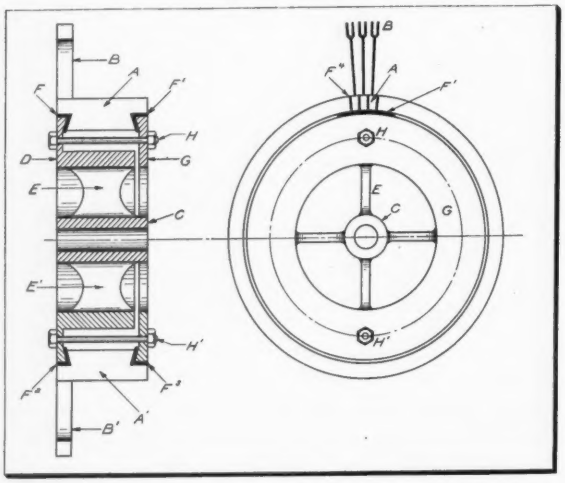


FIG. 14. DETAIL OF MODERN COMMUTATOR CONSTRUCTION

Referring to the cross-section view, Fig. 14, A and A^1 are segments, B and B^1 connectors to which the armature leads are soldered; the former are better shown in the front view at the right-hand side. At C is shown the hub which supports the armature ring

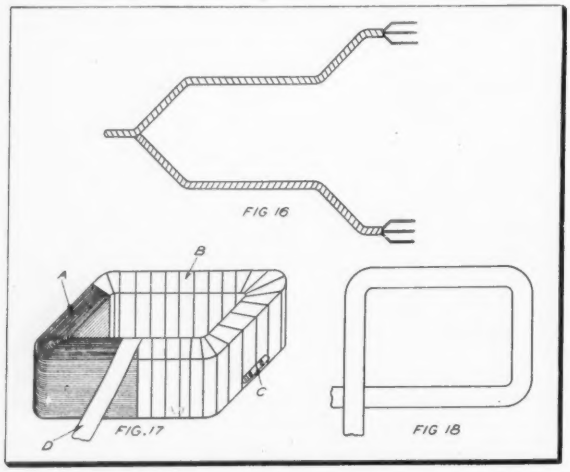


FIG. 16. ARMATURE COIL READY TO BE PLACED IN ARMATURE
FIG. 17. WIRE-WOUND FIELD COIL
FIG. 18. STRAP-WOUND FIELD COIL

D by means of the spider webs E and E^1. Molded mica insulation is indicated by F, F^1, F^2 and F^3, and the clamping plate by G. This plate is clamped securely in place by bolts H and H^1.

In assembling, the commutator ring is laid on a smooth surface and the molded mica ring F-F^2 placed in position. The copper segments are then assembled alternately with the mica insulation, F^4, that separates the segments, after which the insulating ring F^1-F^3 is placed in position and the clamping plate G is bolted in place; the assembled commutator is then ready for turning down and polishing.

Bearings

USUALLY self-alining ring-oiling bearings similar to that shown in Fig. 15, are used on dynamo-electric machinery. The shell or bearing proper, A, has considerable play as it is spherical at the center and is supported by a seat B and the cap E with

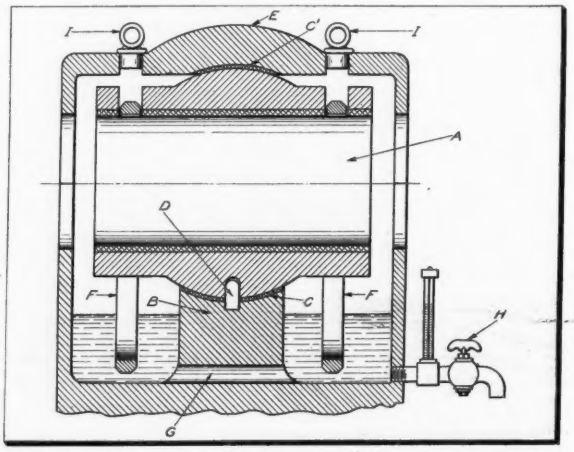


FIG. 15. CROSS-SECTION OF SELF ALINING RING-OILING BEARING

concave babbit-covered surfaces C and C^1; the dowel pin D serves to keep the shell in position within certain limits.

Two oil rings F, rest on the shaft and revolve with it, carrying a constant supply of oil over the shaft from the reservoir below. A hole is drilled at G to allow the oil to circulate between the sides of the

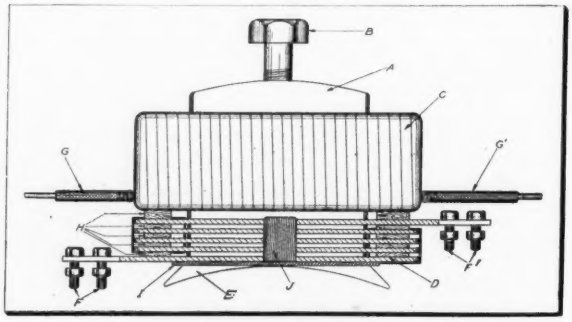


FIG. 19. AN ASSEMBLED FIELD POLE

reservoir and to permit draining from one drain-cock shown at H, which is provided with a gage glass to indicate the oil level. Oil is poured into the bearing through 2 oil holes in the cap, which also serve as peek holes to see that the rings are running.

Winding Details

IN large machines copper bars are commonly used for the armature winding, several bars made up into one coil being the general practice. The bars are separately insulated and when assembled are bound

with webbing and insulated, the completed coil having the appearance shown in Fig. 16. The bare ends at the right are soldered into the commutator connections.

Shunt-field coils are of 2 general types, wire wound and strap wound. Fig. 17 shows a wire-wound coil which has been partially bound with webbing. The wire is first wound on a form and tied with cord, giving the coil the appearance as shown at A. It is then wrapped with the webbing, B, the end D being passed in and out of the coil until the whole is covered. Terminal connections C are soldered to the ends of the coil.

The completed field coil is next placed in a vacuum tank into which is admitted liquid insulating compound which thoroughly impregnates the winding and covering.

Coils employing copper straps are formed by winding the strap on edge as shown in Fig. 18. Such coils are insulated by placing sheet asbestos strips, or other suitable insulating material between convolutions; the copper itself is bare. The completed coil is then finished in the same manner as the wire-wound coil.

Figure 19 shows a completely assembled field pole for a compound-wound machine in which A is the iron pole, B the bolt for attaching the pole to the frame, C the shunt coil, D the series or compound winding, E the pole face, F and F^1 series coil connections, G and G^1 shunt coil connections, H insulating strips separating the convolutions of the series coil, I insulators and J, tape and cord binding.

On machines other than small sizes, the series winding is composed of insulated rectangular copper bars, wound on edge, with air space between the convolutions which are permanently separated by strips of insulating material and held securely by the binding strips like that shown at J in the figure.

ELECTRICAL CORRESPONDENCE

Trouble with Paralleling

I HAVE a dynamo which I will call No. 1, and another machine was purchased to run in parallel with No. 1. They are both Westinghouse, direct-current machines, compound wound. An expert from the shop was sent down to make any necessary changes to make them work together. He removed all the resistance from No. 1 machine and shortened up on the German silver in No. 2 machine, but owing to a new belt on No. 2 machine, did not have much success.

After running No. 2 until the stretch was out of the belt, I tried to put them together, but found that if I had the voltage equal, No. 2 machine would take all the load, so I put all the German silver strips I could get on the series shunt, and the best I can get is an equal division of the load with 110 volts on No. 1 machine and 106 volts on No. 2 machine, so I took out all the German silver and put in a shunt of the same size wire as the feeder without making any difference in the above results.

Both machines are the same distance from the switchboard, but the positive and negative wires on No. 2 machine are larger than on No. 1. If I change the wires so they will offer the same resistance, do you think I can have the load and voltage the same when running them in parallel? I have connected both voltmeters to No. 1 machine to prove it correct, or at least they are equal. J. E.

A. Shunting the series field in compound wound generators in parallel has little, if any, effect on the division of load between them. This will be readily understood from Fig. 1. The series shunt there represented, while ostensibly attached to the series field of A machine, is equally as much a shunt for B machine, due to the fact that the 2 series fields are in multiple between the equalizer cable and (in this case) the

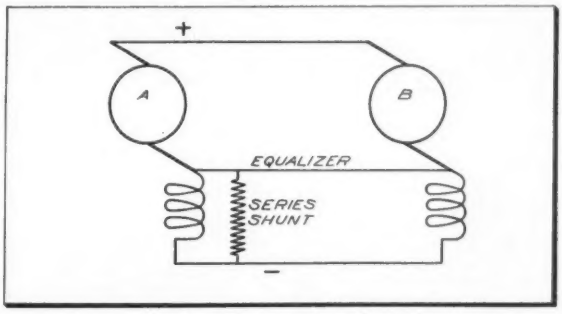


FIG. 1. CONNECTIONS FOR PARALLEL OPERATION

negative bus. So that, when you connected a shunt of cross-section equal to the main feeders across one series field, the division of load was not affected to any appreciable extent, because part of the shunted current was deducted from each field, thus maintaining practically a balance.

Figure 2 shows the proper method of introducing a governing resistance into the circuits of compound generators.

The resistance R, introduced as shown, materially changes the relations of the field strengths and by properly adjusting R, a proper division of load can be obtained. In actual practice it is, however, not customary to use a form of resistance grid in circuit with the fields—R is generally a length of cable connecting machines to the board.

Figure 3 shows how the actual practical division is affected. Instead of having cables exactly the same

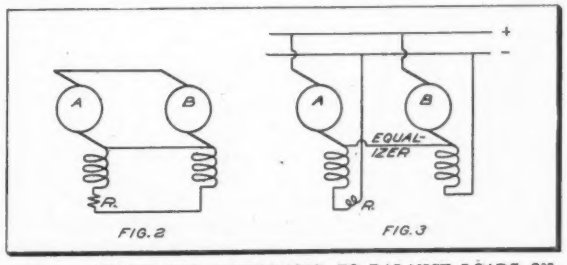


FIG. 2. RESISTANCE INTRODUCED TO BALANCE LOADS ON GENERATORS IN PARALLEL

FIG. 3. PRACTICAL METHOD EMPLOYED FOR DIVIDING LOAD ON GENERATORS

length, a few extra feet of cable are used on the machine, which tends to take most of the load. In your case,—as No. 2 takes all the load, equal division of current can be affected either by increasing length of No. 2 cables, or by using smaller cables; either process, of course, being equivalent to introducing resistance as at R in Fig. 2. It goes without saying that similar results can be obtained by shortening cables of your machine No. 1, or using heavier copper.

After the machines very nearly divide the load properly, a finer adjustment can be made by placing iron washers between the lug of cable and terminal plate, thus introducing a small additional resistance. See Fig. 4.

There is still another way in which machines can be made to take proportional loads—viz.—by shifting brush yoke. A forward shift causes the machine to take less load, while a backward shift causes machine to take more load. This does not mean back of neutral, but only back from its original position. Figure 5 explains this quite clearly. The normal running position of brushes is, say, at A. Moving brushes to B, would cause machine to take less load; moving them to C, would cause an increase of load. This adjustment of current by means of brush shifting is, of course, limited to the range of movement compatible with good commutation.

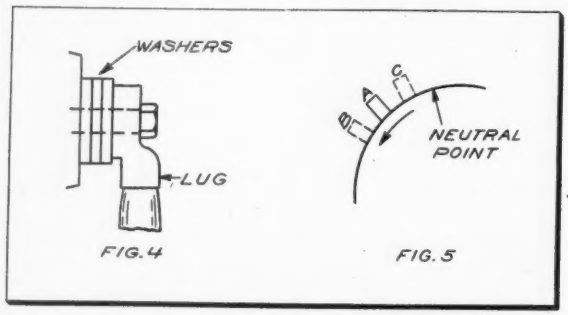


FIG. 4. MAKING FINE ADJUSTMENTS OF RESISTANCE BY MEANS OF IRON WASHERS
FIG. 5. SHIFTING BRUSH TO EQUALIZE LOAD

To summarize then,—to make your machine No. 2 take less load and No. 1 take more, you may:

(a) Lengthen cables from series field to board on No. 2. This is usually negative cable.

(b) Shorten cables from series field to board on No. 1.

(c) Use smaller cables from series field to board on No. 2.

(d) Use larger cables from series field to board on No. 1.

(e) Use iron washers under lugs of cables on No. 2 to increase resistance of circuit from series field to board.

(f) Commutation permitting—shift brushes on No. 2 a little farther forward than they are at present (forward meaning in direction of rotation).

(g) Commutation permitting—shift brushes on No. 1 a little back of their present position.

Aside from this, it might be well to note how the engines behave while load is applied. It might be possible that engine No. 1 slows down much more than No. 2, due to governing, etc., or that belt No. 1 slips much more than belt No. 2—either condition, of course, resulting in a lower speed in machine No. 1 and a consequent dropping of its load. V. E. Johnson.

Meter Error

A QUESTION has been brought up concerning the reading of a wattmeter. A house circuit on which ought to be used a 220-volt, single-phase, 60-cycle meter is metered in error by a 110-volt meter. The potential coil did not burn out and I claim the reading is approximately twice normal. What is your opinion of this?

What effect would the following condition of affairs have on the readings of a polyphase watt-hour meter: We have a 2200-volt current transformer which is connected to a 1100-volt circuit and the current coils of an integrating polyphase wattmeter?

F. G. F.

A. Except for abnormal heating and flux density, a 110-volt watt-hour meter will read accurately on a 220-volt circuit. With a given current flow, twice as much power is being delivered, and as the potential coil flux is doubled, the meter will in turn run twice as fast as it did at 110 volts, so that it still indicates the power consumption. Actually, however, the meter would run slow on 220 volts. In the first place, the voltage coil would heat up and so acquire a higher resistance. This would mean that less than twice the 110-volt current would flow. Secondly, with the increased current and the corresponding increased flux density, the iron would become more or less saturated so that more ampere turns per 1000 lines would be needed at 220 volts than at 110 volts.

For example, keeping the current constant, we can tabulate a hypothetical example as follows:

Volts	Current in Pot. Coil	Flux per Ampere	Total Flux	Power Integrated by Meter	Power Actually Used
110	0.01	100,000	10,000	$110 \times C$	$110 \times C$
220	0.0195	80,000	15,600	$\frac{15,600}{10,000} \times 110 \times C$	$220 \times C$

Unity power factor is assumed in the above. This shows then that our hypothetical meter would integrate only about $172 \times C$ watts per hour for a consumption of $220 \times C$ watts. In addition to this heating and saturation error there would be the additional error of a changed leakage coefficient due to the greater flux density.

Regarding current transformers, the voltage rating on them is only an indication of the insulation strength between the primary and the secondary. Thus with 10 to 1 transformer, 100 amp. primary would pass 10 amp. through the secondary, regardless of whether the potential between the line wires were one or one million volts. Your 2200-volt current transformer is perfectly accurate on a 1100-volt circuit, or on a 110-volt circuit, for that matter.

IN THE TEST of a kerosene oil engine, by H. D. Wile, given in the Electrical World, some interesting figures are shown. The oil used was of a density over 40 deg. Baume. It was made by the Falk Engine Co., using the Secor-Higgins carburetor, which mixes water with the incoming kerosene vapor. Tests were made to determine the best jacket water temperature, the best time of ignition, the best amount of water to be used in the cylinder, and an economy run at different powers.

The tests showed the most efficient jacket water temperature to be 175 deg. F., and the best angle of advance for the ignition, 36 deg. ahead of the dead point. Best results were obtained with a mixture of 34.4 per cent water in the kerosene mixture, or a ratio of 2 parts kerosene to one part water. It was found that approximately 16 per cent of the heat was absorbed by the jacket water, 55 per cent was wasted in radiation and exhaust. The kerosene consumption during the run was as follows: Brake horsepower, 4.2, kerosene per brake horsepower-hour, 1.55; horsepower 5.5, kerosene 1.26; horsepower 7, kerosene 1.05; horsepower 8.73, kerosene 0.93; horsepower 10.3, kerosene 0.87; horsepower 11.9, kerosene 0.94; thermal efficiencies were respectively 7.3, 10.1, 12.1, 13.8, 14.7, and 13.6. With kerosene at 10 cents a gallon, the fuel cost in operating this outfit would be 2.1 cents per kilowatt-hour. The engine ran at about 450 r.p.m., showed a mechanical efficiency of 66 per cent at the highest load, and 82.8 at the heaviest load, and used from 230 to 300 lb. of cooling water per hour.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

An Explosion Motor Locomotive

By J. H. Blakey

SINCE the extensive adaptation of the explosion motor to automobiles, attempts have been made to construct locomotives using this motive power, but for various reasons these attempts have, until recently, not been successful. Some of these reasons are obvious: for instance, the cost of the fuel used in the ordinary locomotive is so much lower than that of the combustibles required for explosion motors that competition between the two has been impossible on that account alone. The element of the weight of this cheap fuel, in addition to the weight of the boiler and water, instead of being detrimental to the steam locomotive has been an advantage because of the necessity of the weight to give starting power. The efficiency of 21 to 24 per cent of the explosion motor, against 9 to 10 per cent for the steam engine has not been sufficient to overcome this advantage of cheaper fuel.

On the other hand, it can be readily seen that there are many situations in which a locomotive which produces neither smoke nor cinders, and which can be started up at any time with little preparation, would be invaluable. In the Schneider hydrocarbon locomotive, which has recently been produced in France, the difficulty of costly fuel has been overcome by the use of crude naphthaline. It is constructed for use in workshops, shipyards, and other places where the presence of smoke and cinders would be objectionable or dangerous. Consequently it is of small size, weighing only 18 tons, its total length being 18 ft. 10 in. It is capable of developing at starting a maximum tractive effort of 38 tons, and will move a train of 160 tons. The motor is of the usual automobile type, 4 cylinders measuring 5½ by 7¾ in. and giving 70 hp. at 950 r.p.m.

FIG. 1. AN INTERNAL COMBUSTION LOCOMOTIVE

Ignition is by high tension magneto, with automatic advance suited to the varying speeds of the motor. The cooling is by thermosiphon, but with boiling of the water and condensation in a radiator placed above the driver's cab, so that the tank around the motor is always filled with water at boiling point. The motor is constructed to work with any volatile hydrocarbon, or with naphthaline, which melts at 175 deg. F. The principle of the use of this latter combustible is that it is kept at a constant and well defined temperature of 212 deg. F., in contrast with the uneven fusion which occurs when the escaping gases are used for this purpose.

The motor therefore has 2 carburetors; one for benzene or other similar hydrocarbon, and one for naphthaline. The one or the other is put in action by the turning of a 3-way cock. The motor is started with a volatile hydrocarbon which is liquid at ordinary temperatures, such as benzene, gasoline, or carburetted alcohol, and as soon as sufficient heat has been generated to fuse the naphthaline, an index connected with the pump which raises it into the tank, and which is driven by the motor, indicates that fusion is complete. The hydrocarbon first used is now shut off and the motor continues to work with naphthaline. This is the crude product, in flakes, selling at $16 a ton, and as the consumption per horsepower-hour is only 9 to 10 oz., the cost per horsepower-hour does not exceed one cent, which compares favorably with the cost of operating a steam locomotive.

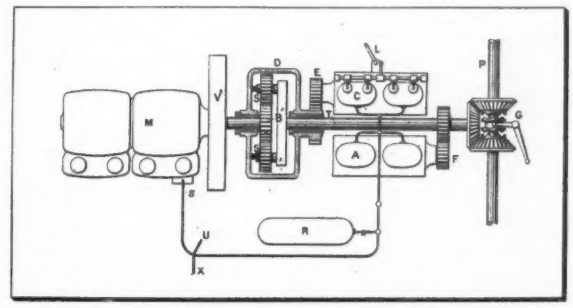


FIG. 2. DIAGRAM OF THE HAUTIER AEROTHERMIC TRANSMISSION

M, explosion motor; V, flywheel; D, differential mechanism; B, motor gear; S, satellites; T, transmission shaft; E, compressor gear; L, compressor lift valves; A, compressed air motor; F, starting gears; G, reversing lever; P, wheel axle; R, reservoir of compressed air; S, Letombe automatic starter; U, whistle; X, compressed air brake.

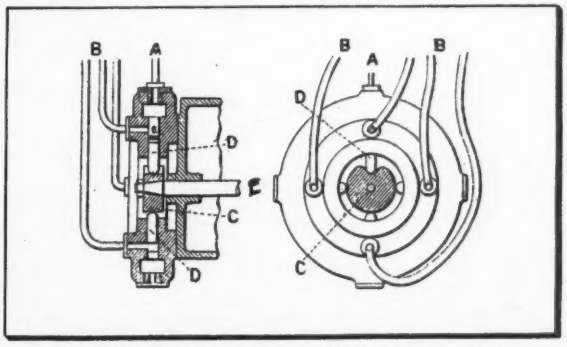


FIG. 3. THE LETOMBE AUTOMATIC STARTER

A, connection with air compressor; B, tubes to cylinders; C, grooved cam; D, piston valves; E, motor shaft.

The transmission is the Hautier aerothermic, which has been in successful operation for some years, and which is represented in Fig. 2. The motor shaft is connected with the main transmission shaft by an epicycloid gearing, the gear box having an outside gear which drives a 4-cylinder air compressor. This compressor feeds a compressed air motor which is also connected with the transmission shaft by gearing. In addition the compressor supplies the air reservoir R.

from which air is taken for the whistle, the brake and for the Letombe automatic starter. This starter (Fig. 3) has been designed primarily for automobiles and consists essentially of a grooved cam working on the motor shaft. Around the cam are arranged 4 piston valves, each in communication with one of the cylinders, and allowing the supply of compressed air to reach it. It has been found by experience that when a 4-cylinder motor stops, one piston is always in position to receive the explosion. The cam is set so that that cylinder will receive the charge of compressed air, followed by the next in turn. As soon as the motor starts under explosion the air is shut off, and the piston valves rising in their bearings by means of suitable springs, friction on the cam after starting is avoided.

The working of the transmission is as follows: The motor being in action, the compressor valves are opened and consequently there is no resistance to the rotation of the gear box, caused by the turning of the planet wheels upon themselves. As long as these valves are open the gear box will continue to turn; but as soon as they are closed the pressure rises, a resistance to its rotation is set up and the gear box becomes stationary, causing the planet wheels to drive the shaft. The air motor being now started, the locomotive starts up under the action of the 2 forces. When under way the air motor is shut off; the gear box remaining stationary, the motion continues by direct transmission of energy, the differential now acting simply as a speed reducer.

POWER PLANT CHEMISTRY

Water, Its Chemical Properties, and Sources for Feed Water Purposes

NEXT to the fuel in importance, as a raw material in power plants, is the water used for boiler feed purposes. It is necessary for the generation of steam and its purity has much to do with the economical operation of the plant, to say nothing of the safety of boilers.

In its pure state, water is composed of hydrogen and oxygen in the proportion 2 to 1, hence the chemical symbol H_2O. In their uncombined state these 2 elements are colorless, odorless, tasteless, transparent gases, but when they combine in the proportions stated above they form the liquid water which is odorless, tasteless and transparent, but has a greenish blue tinge when considerable thickness of the water is looked through.

There are several ways by which water may be formed from its elements, but 2 most common are, first, by burning hydrogen in an atmosphere of air or oxygen and cooling the products of combustion, and second, by passing an electric spark through a mixture in proper proportions of the 2 gases.

Water is the most general solvent of all liquids, not that it is the most active, but there are few substances which are not dissolvable to some extent in water. This characteristic accounts for the universally, chemically impure state in which we find water in nature. Even rain water in mountain regions, where the atmosphere is free from the smoke and dust of cities, contains more or less impurities which are picked up in the atmosphere and it even dissolves the gases of the atmosphere. When the water reaches the earth it begins immediately to dissolve mineral and gaseous matters, and carry them in solution.

The impurities which water contains are, of course, determined by the character of the soil through or over which it passes. For use in the power plant, it is not necessary nor, indeed, desirable that the water be chemically pure; if it were the boiler shell and tubes would soon corrode due to the solvent property of such water. On the other hand, if the water contains impurities to an excessive amount, these will be left in the boiler as floating precipitates, or scale forming material, which are detrimental to the operation of the boiler.

To secure the highest efficiency, therefore, it is necessary to determine the character of the water which is being used for boiler feed purposes and treat the water so that the injurious impurities do not enter the boiler or are precipitated in a harmless sludge which may be blown off periodically without taking the boiler out of service.

Sources of Feed Water and Impurities

SO far as we are concerned, the source of water is the rain which, when it reaches the earth, contains more or less carbonic acid, ammonia and sulphurous and chlorine gases in solution, depending upon the industries of the community where the rain has fallen. The effect of these impurities upon a boiler would be to cause pitting or corrosion. Rain water is seldom, if ever, used for boiler feeding, owing to the difficulty of securing a sufficient and regular supply, so its treatment will not be discussed here.

Snow water is in the same class with rain water. This can be obtained in a pure state only at the end of a heavy snow storm after the impurities of the atmosphere have been taken up by the preceding snow flakes. Surface water is rain or snow water with which is perhaps some spring water which has run over the surface of the earth and become more or less polluted with soluble substances on the surface of the ground.

Spring water coming to the surface of the earth through strata of gravel, rock or coal may have picked up gaseous impurities given off by decaying vegetable and animal matter, then coming in contact with lime rock the water becomes hard.

River water is that found in streams and is composed principally of surface water mixed with more or less spring water. The impurities, therefore, are rather complexed and added to those mentioned above may be found albumoids and free ammonia. Then, too, river water carries in suspension earthy matter, leaves, sticks and trash of all kinds. Factories and other industries may discharge refuse into the river which complicates matters and makes the satisfactory treatment extremely difficult.

Water from wells several hundred feet deep is most likely to be hard, some of it containing a large percentage of scale forming material. The impurities usually consist of mineral salts which the rain has taken up in its descent through the earth. As a rule, water from deep wells is comparatively uniform in consistency and once a satisfactory means for removing the impurities has been determined, it may be used continually.

Impurities found in water may be classified under 2 general heads: Suspended matter which may be removed by mechanical means, and dissolved matter which requires chemical purification. Suspended matter may be inorganic, such as mineral matter, grit, sand, clay, etc., or organic such as animal and vegetable matter, micro-organism, algea and peaty matter. Dissolved matter consists of gases like carbon dioxide, hydrogen, sulphide, chlorine, or solids which may be inorganic, organic, vegetable, animal and mineral matter.

For boiler feed purposes we are interested in removing all material which will be a detriment to the metal in the boiler or reduces its efficiency. Suspended matter is quite readily seen and the remedy is obviously to pass the water through a strainer, when the impurities are inorganic, or through a filter when organic.

Dissolved impurities, however, are not so easily seen nor removed, and some other means must be resorted to. First of all an analysis is necessary to determine the character and amount of the impurities, and from this work for a treatment which will leave the water free from scale forming material and corrosive impurities. The method of making this analysis in detail will be given in an early issue.

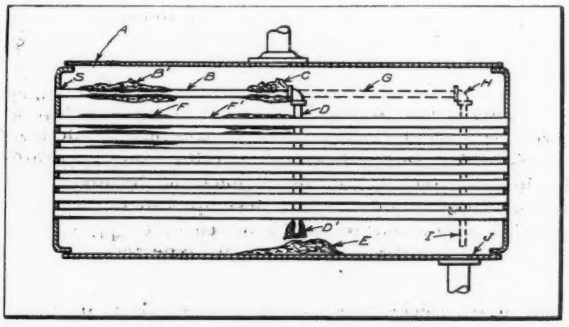
PECULIAR SCALE FORMATION

Cause and Remedy

By C. W. Dunlap

IN a fellow engineer's plant recently the usual question of trouble with scale formation came up, and the engineer was emphatic in his statement that he had succeeded in getting 2 of his battery of 5 boilers piped up in such a way that he expected never to have any more scale troubles. I was about as much convinced that he had discovered a method of scale prevention, as it is a possibility to get by the undertaker.

After some other subjects were discussed my friend asked me to stay around until he opened one of the boilers that he had changed the piping in, and see for myself how clean it was and especially how free the tubes were from scale formation. While the engineer was knocking in the 2 front plates, he remarked that he didn't think it would be necessary to wash out the boiler as it had been in service only 4 weeks and he had always kept them in 6 weeks each; but the checks appeared to be clogged up in some way so, as he put it, "You never can tell. I might as well wash out and examine the checks at the same time."



LOCATION OF SCALE IN BOILER

When the boiler was opened, to our surprise we found the feed line in much the same condition as is shown in the accompanying sketch. The boiler at A is one of the 5, 60-in. by 16-ft. return-tubular boilers, with 44 4-in. tubes. The boilers were originally fitted with the overhead perforated feed line extending back 12 ft. from the front head; this was removed by my friend, and the line shown at B put in instead. At B^1 is shown a scale formation nearly as large as the diameter of the pipe, and there was a large amount of scale on the top row of flues directly under the scale at B^1, as is shown at F.

To get the pipe out it was necessary first to remove the pipe at D. With this pipe out on the fireroom floor it looked much as it is shown at D^1 with the end nearly closed and about 2 in. of very hard scale around the outer surface of the pipe. To get the pipe B out it was necessary to saw it off close to the front head at S, when this pipe was out it looked much as is shown at C and B^1. Next, to get at the direct cause of the scale formation in these particular places, I knocked all the scale off these parts and found the pipe badly corroded and pitted with several small holes through it, this causing the scale to form at these places.

After the piping was all removed my friend crawled into the lower manhole and found considerable scale, as is shown at E; fortunately this was all loose scale and did not adhere to the lower shell. After the entire arrangement was removed, new piping was procured and the line was extended as is shown by the dotted lines at G, H and I; this allowed for the scale, if any, to be blown out when the boilers are blown off, which should be once every 12 hr. at least, where so much carbonate of lime is in the feed water.

UNIFLOW ENGINES

IN connection with the description of the Uniflow engine given in the January 1, 1913, issue of Practical Engineer, and the article on the locomobile in the issue of July 15, it will be of interest to know that the 2 improvements are now being combined to gain the advantages of both systems. The development is the Wolf Uniflow locomobile, which has a light piston valve admitting steam superheated to 650 deg. F., through ports in the sides of the cylinder walls. Opposite to the admission port is an exhaust port controlled by a piston valve of larger size, which transfers the steam to the low-pressure cylinder, from which it passes by ports in a ring around the cylinder walls to the condenser.

Warren H. Miller, in an article in the Electrical World, states that presumably as a consequence of the greater efficiency of the Uniflow cylinder, the flue gas jacketing of the tandem compound unit has been abandoned, also the superheater between the high and low-pressure cylinders, and the cross-compound type of engine is used, with direct passage of steam through both cylinders, giving results that have been below the best so far done with tandem-compound arrangement, and 2 superheaters.

Professor Durfner, of the University of Prague, found a steam consumption of this type of locomobile, 8.05 lb. per brake horsepower-hour, at 644 deg. F. steam temperature. With the usual superheat temperature of around 750 deg. F., 9 lb. is the common value of steam consumption for the older type of locomobile. The output ratings on the new Wolf Uniflow locomobiles run from 250 to 600 hp., with floor areas 20 ft. 5 in. by 8 ft. 9 in. for the smaller unit, and 30 ft. 3 in. by 12 ft. 9 in. for the larger.

IMPROVING COMBUSTION IN SMALL PLANTS

CO_2 Recorders, Finding Leaks, Test Results

By W. H. Odell

FREQUENTLY the traveling man, if he is an engineer familiar with such matter, is shown a recorder outfit and regaled by the engineer in charge of the plant with a summary of what he is going to accomplish with the aid of such instrument, but coming around again a few months later, the traveling man finds the instrument out of use and covered with dust.

It must not be assumed that the writer is opposed to the use of the CO_2 recorder or any other instrument, or device, that will enable the engineer in charge of a plant to stop a leak; but it is quite evident that in order to get the full benefit of the use of such an instrument as the recorder, it should be in the hands of men who have had experience, and who know how to make the analysis without error, as well as correct any faults shown by such analysis.

It is a well established fact that a low percentage of CO_2 comes from 4 principal causes; viz., unskillful firing, imperfect air supply in proportion to the fuel being burned; i.e., thickness of fuel bed, air leak through the setting or smoke connections, or by allowing the spent gases to pass off at too high a temperature, and again it is unfortunate that in articles on the use of this valuable instrument we are not told how to correct the errors discovered, if there are any, and the writer has never yet learned of a case in actual practice where "perfect combustion" was attained.

Possibly the most serious defects as shown by analysis, are air leaks through the brick setting and smoke connections, and possibly the most direct way of discovering where they are is to throw something in the furnace, such as oily waste, etc., and then close the damper and the smoke will come out of every place the air enters. Of course the large leaks can be calked up with some material that will stand the heat; but this test will in many cases show the smoke coming through the side walls, in which there is no discernible crack, and possibly the best method of stopping such leak is to whitewash the entire walls, as the lime will enter the most minute openings and close them up; this has proved of much value in many cases.

Of the other causes of low percentage of CO_2 in chimney gases with the remedy for them, the writer has not time to go into details at this writing, but possibly an example will point out a moral.

This is the case of an internally fired, vertical fire-tube boiler, in which there was no possibility of any air entering except that which entered through the furnace. This boiler, though of a class that is often sneezed at, gave what is believed to be the highest efficiency ever obtained in actual practice and we quote from the report of one of 4 experts who made evaporative tests at different times; but all in accordance with the code of rules advised by the American Society of Mechanical Engineers; and in passing, it may be said this duty ran from 11.79 up to 13.79 lb. water evaporated "from and at" per pound combustible; so the following figures copied from one of the reports above referred to are full of meaning to engineers who are looking for facts.

The dry coal contained: Carbon	83.28	per cent.
Hydrogen	4.49	"
Nitrogen	1.57	"
Oxygen	3.39	"
Ash	6.56	"
Volatile Sulphur	0.71	"
	100.00	"

Computed calorific value of 1 lb. of dry coal was 14,635 B.t.u. The coal on the trials contained 6.63 per cent ash and refuse, as against 6.56 by analysis.

Samples of gases analyzed with the Orsat apparatus gave as follows.

Sample taken 3 to 6 min. after cooling gave:

	CO_2	O	CO
Sample 2.	16.2 per cent	3.0 per cent	0.0 per cent
" 3.	14.4 "	0.0 "	3.0 "
" 5.	14.4 "	6.4 "	0.0 "
" 9.	15.5 "	4.6 "	0.1 "
" 10.	12.8 "	7.8 "	0.6 "
" 12.	12.7 "	6.3 "	1.6 "
" 15.	12.0 "	6.0 "	0.4 "

Samples taken just after breaking up fire:

16.08 per cent 4.0 per cent 0.0 per cent

Sample taken as fire was being raked through small door 4 by 6 in.:

Sample 8.	12.8 per cent	7.4 per cent	0.0 per cent
" 13.	10.2 "	5.5 "	5.1 "

Sample taken when slicing fire through a small slice bar hole:

Sample 11. 9.2 per cent 7.4 per cent 3.9 per cent

The average pressure on boiler by steam gage while the test from which the above was taken was 79.7 lb. and the average temperature of escaping gases but 389 deg. F., and on several occasions the writer saw less than 20 deg. F. difference between the steam and gases passing from the boiler, which shows that no great amount of heat was escaping up the chimney without doing useful work.

The expert in charge of the test and from whose report the above data is copied, later on says:

"The fires on these tests were very thin, being from 3 to 5 in. thick. This accounts for the large percentage of free oxygen obtained by analysis. The absence in general of unburned gas, shows perfection in combustion. The large amount of air passing through the thin fire was a loss only by the amount of heat passing with it to the stack." And he "is of the opinion that the fire should be carried from 6 to 8 in. thick."

In conclusion, the writer of this article wishes to go on record as an advocate of an accurate method of metering the water feed to a boiler, and accurate weighing of coal fed to the furnace, as fixtures in a fire room, and if good use of these appliances is made, the engineer in charge can soon learn to get all out of the coal that can reasonably be expected.

To bend copper pipes of small bore, those up to ½ in. in diameter may be worked empty if they are warm. For pipe ¾ in. in diameter and over, loading must be resorted to, sand being used for slight curves, but resin or lead is preferable for anything approaching a right angle. Resin has a tendency to crack, which may be avoided by warming at the bend as the work proceeds. To remove the lead in a bend pipe, use a blow lamp. For bending pipe of steel or any metal with a split butt joint, as, for instance, conduits, a mixture of pitch and sand is recommended, the pitch being melted and the sand well stirred.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

A NEW TYPE OF SUCTION GAS PLANT

A TYPE of suction gas plant which has recently been brought out by Crossley Bros., Ltd., of Manchester, England, in order to overcome certain difficulties experienced by users of the usual closed hearth type of suction plant, is here illustrated. When using the poorer and smaller grades of anthracite or coke, there is a tendency for the fuel to adhere to the sides of the firebrick lining and for clinker and ash to choke the fire-grates, which under ordinary working conditions interferes with the smooth and continuous working of the engine.

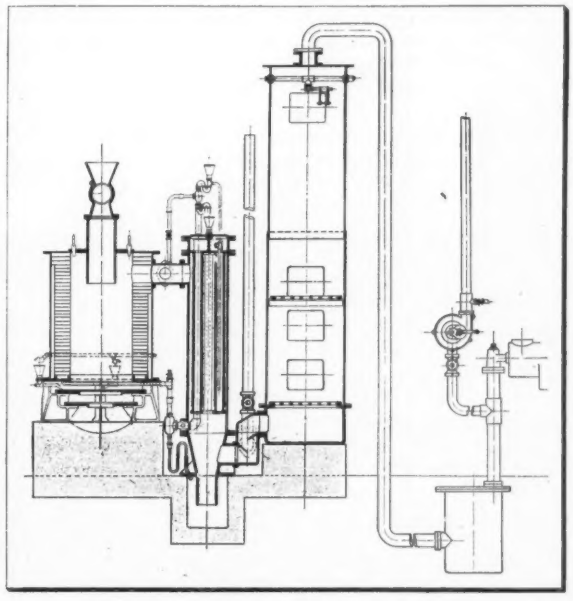
In this new plant special facilities are provided for loosening any clinker which adheres to the firebrick lining, in the shape of poke holes on the top of the generator. These poke holes are placed in such positions that the poker is in a line parallel and immediately adjacent to the brick-work itself and every part of the lining is accessible.

It will be seen that the fire-grate is open to the atmosphere. It is composed of a number of stepped fire-grate plates of such a diameter and so placed as to stand outside the angle of repose of the fuel. The center column of fuel rests upon its own bed of ash, every portion of the grate can be cleaned while the engine is at work. Clinker and ash can be removed without in any way prejudicially affecting the work of the engine or lowering the quality of the gas. The condition of the fire and the accumulation of ash and clinker are in full view of the attendant.

Another important improvement is the removal of the vaporizer from the generator, which not only simplifies the construction of the generator, but also simplifies the working and facilitates repairs when necessary. The generator is used for making gas only, the steam raising and the cleaning and cooling of the gas being done separately. The generator is of the simplest possible construction and has few joints. Trials have shown that the plant can be worked for weeks on end without the fire being taken out of the generator.

The main vaporizer consists of a rectangular box which acts as a gas connection between the generator and scrubber and which contains a number of gilled tubes. These tubes are supported from the top only and are thus free to expand and contract without any fear of breaking a joint or fracturing the tubes. The water is led up a central mild steel tube to the bottom of the cast-iron gilled tube from which point it rises to the overflow at the top and passes to the steel tube of the next cast-iron gilled tube, and so on. The direction of flow is thus in harmony with the convection currents. These gilled tubes are in series, the last one being a flash or superheating tube. The steam is taken from the last tube to the fire-grate.

With this design of vaporizer, the gas which has to be cooled is external to the water which has to be heated, so that the water is surrounded by the jacket of hot gas. The vaporizer serves the double purpose by making the steam and cooling the gas before it gets to the scrubber. Before leaving the vaporizer, the gas passes through 2 cascades of water forced from the overflow of the scrubber and direct impingement is thus secured and the heavier impurities are washed out of the gas before it reaches the coke. A direct effect of this is that the work the coke scrubber is called upon to do is greatly reduced and the coke need not be renewed so frequently. The water supply to the vaporizer is automatic and is so arranged that



CROSS-SECTION OF SUCTION GAS PRODUCER

the engine exactly regulates the quantity of the water fed to the external vaporizer according to the load. On light loads little water is delivered, while on heavier loads the quantity is increased. In place of the usual blower type of starting a fan an induction fan is used. This is placed in the pipe line to the engine and as near as possible to the engine with a blow-off pipe led through the engine house roof. Provision is made to raise the necessary quantity of steam for separating purposes from the stepped grate as soon as the fire is lit and hence it is not necessary to wait until the vaporizer has been started up. This interesting development in power house plant design, for which great reliability is claimed, represents a distinct step forward in gas producer design.

THE MEN WHO SUCCEED best in public life are those who take the risk of standing by their own convictions.
—Garfield.

GAS ENGINE CARDS

By N. A. Nabal

HERE are some cards from a 3-cylinder 13 by 14-in. gas engine, Westinghouse vertical type, rated at 125 hp., operated with natural gas. This engine has been in service for 12 yr., working day and night a greater part of the time. The cards show that the spark is a little late.

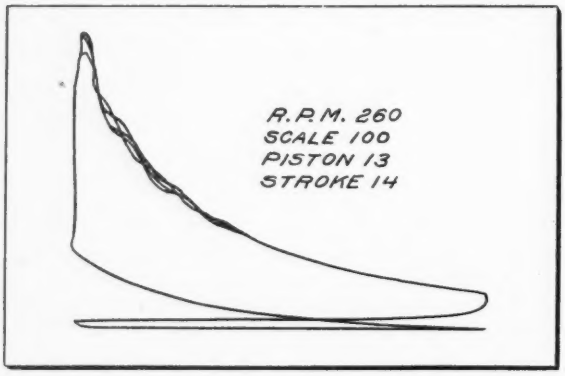


FIG. 1. DIAGRAM FROM NO. 1 CYLINDER OF WESTINGHOUSE VERTICAL GAS ENGINE. WAVY LINES DUE TO LONG CARD

We recently advanced it 4 deg. and did not think it advisable to advance it any farther as too early an explosion would bother in getting the engine started.

TRAINING FOR GAS ENGINEERS

By G. W. Muench

AMONG those operating power plants, the gas engineer is the latest addition, as the gas engine is a comparatively new power machine and naturally less is known about it by the average engineer than about the steam engine and its accessories. Ambitious engineers are learning as much as possible regarding the gas engine power in general for they are likely, at any time, to come in contact with gas engines in almost any plant. One battle that the gas engine has had to fight is making good with operators who do not understand it. The man who has bought an automobile has trouble the second day out and cranks and cranks, but with no result. After a few trials he speaks of the engine in uncomplimentary terms but does not know where to look for the trouble. He thinks little of paying several hundred dollars for his car; why not spend $25 more and study the automobile a little in the evenings of each week and thus save many times that amount in the upkeep of his machine.

When an engineer who has operated steam plants for years attempts to operate a gas plant of several hundred horsepower without knowledge of the principles of a gas power plant, he is likely to encounter a lot of trouble. Why not spend a little time and a few dollars to learn about a gas plant and then tackle the job and make good? No man would attempt to run a steam plant without study and experience; why should he attempt to run a gas engine plant without at least a little preparation and knowledge of the elementary principles of the power that he is handling?

One difficulty has been the lack of means to get a practical education in this subject without going through a course of theory which requires a lot of preparatory work. Schools are, however, now in existence throughout the country which will give just the instruction needed for operating gas engines and producers, and an addition to their ranks is the Seattle Engineering School at Seattle, Washington. This school teaches steam, gas and electrical engineering,

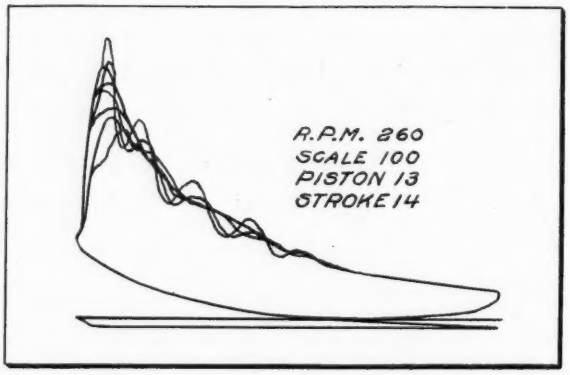


FIG. 2. DIAGRAM FROM NO. 2 CYLINDER

either a complete, thorough course, or the fundamental principles and practical knowledge of care and operation. Many good operating gas engineers cannot get promotion because they have not theoretical knowledge to go with their experience. A school such as the one mentioned will give them this in a few weeks and fit them for passing examinations and for greater responsibility.

Another need is that of salesmen in the orient who can compete as they should with salesmen from Europe. European salesmen are not only proficient in selling, but are technically educated and can help a man out of his difficulties with his machinery as

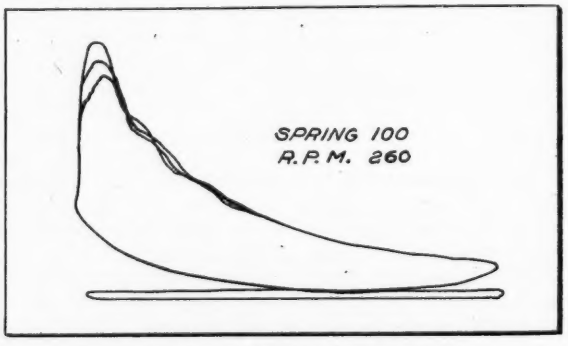


FIG. 3. DIAGRAM FROM NO. 3 CYLINDER

well as emphasizing the talking points of the product that he has to sell. A gas engine salesman should, at least, be able to explain properly the working principles of the gas engine and the use of its various parts.

With progress in the present lines, it is quite certain that every power plant engineer will sooner or later come to the point where he must have to do with a gas engine or gas producer, and if he has had a practical course in such machinery he will be able to discover and remedy so-called gas engine troubles in short order. He will also be in position to remedy difficulties with marine and automobile engines to the great satisfaction of himself and his brother men and probably to his own pecuniary profit.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

POOR PACKING BREAKS FOLLOWER

MY attention was recently called to a boiler feed pump which stopped suddenly and could not be moved with a 4-ft. bar. Having reached the scene of the trouble, the usual steam trial was given, then the bar, but without result. The cylinder head on the water end was removed and showed one of the pistons of this duplex pump to be wedged up so tightly to one side of the cylinder that the follower plate, Fig. 2, was badly bent and cracked so badly it was almost beyond repair.

The packing had been cut diagonally to allow one end a long lap over the other and the piston being a little small for the cylinder on account of reboring, left considerable space to be filled with the packing, and the long taper end had curled over the edge of the follower until it came to the thick end of the long lap which made an excellent wedge upon which the piston follower had been drawn, as the packing had

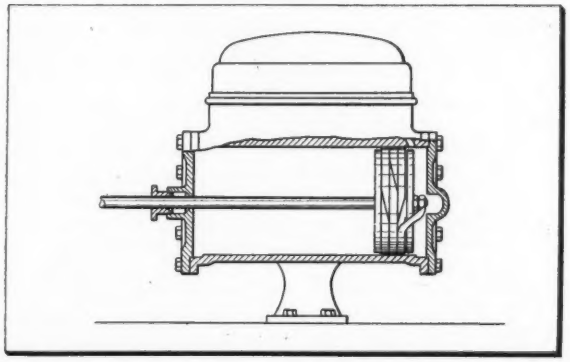


FIG. 1. PISTON WEDGED IN CYLINDER BY DIAGONALLY CUT PACKING

just lapped over the edge of the counter bore, it would be supposed, the piston was overriding.

This was not the case and before explaining the cause further I must relate the trouble in removing the bent follower plate. The nuts were removed from the end of the rod but no I bolts were strong enough to draw the plate out and after some careful examination, seeing that the follower alone was wedged, I took the sledge hammer and placing a piece of babbit on the end of the rod, drove the rod back through the follower plate.

This done, the piston could be moved at will with a small 24-in. bar; but there being no way to get a draw bolt hold on the plate, I took a common round-headed bolt, passed the head through the hole in the plate the head coming down on the edge of the hole on the inside of the follower plate, making an obstruction in the path of the piston rod. The piston rod was then pushed back with a bar, against this obstruction and the follower plate punched out of the cylinder.

There are many kinds of hydraulic piston packing and that generally used on feed pumps is called square, hot or cold water packing. The engineer had found in the plant a coil of packing the right size, and used it without knowing whether it was hot or cold water packing. And while the temperature of the feed water remained fairly low the pump gave no trouble, but as the returns were coming back hot, the packing became so hot it expanded, became soft and sticky and the long taper splice adhered to the cylinder wall sufficiently to cause the follower to ride upon the wedge, and whether the steam pressure pulling on it or the excessive use of the bar caused the break in the follower plate, can only be conjectured.

Figure 3 shows a side view of the long diagonal lap method of breaking joints on piston packing which some engineers prefer. The follower plate was straightened out and a large washer 3/16 in. thick was fitted over the rod between the nuts and the follower plate to strengthen it. Hot water packing was obtained and cut in the "step form" to break the

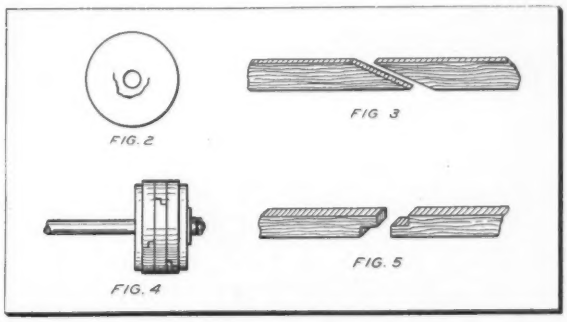


FIG. 2. CRACKED FOLLOWER PLATE BADLY BENT
FIG. 3. LONG DIAGONALLY CUT PACKING
FIG. 4. PACKING CUT IN STEP JOINT, 3/16-IN. WASHER HOLDING BROKEN FOLLOWER PLATE
FIG. 5. THE STEP CUT PACKING TO BREAK JOINTS

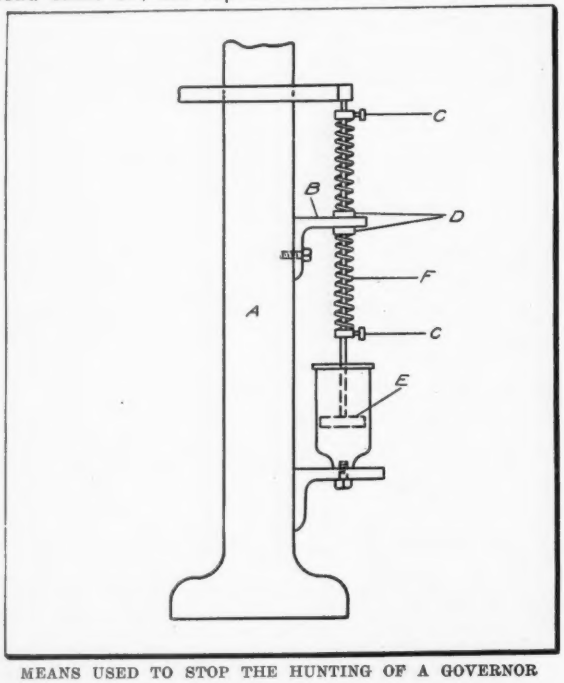
joints. Figure 4 illustrates the piston after it had been packed and the washer put on under the nuts. Figure 5 shows the ends of the packing cut in the "step form" to break the joints.

This method of cutting the packing is a slow and tedious job, but if properly done will wear enough longer to pay for the extra time expended. Some engineers prefer the solid rings in place of cutting the packing to fit the cylinders. They are very good if only hot water packing is used where the pump takes warm returns from the heating system or hot water from an open heater. When changing to cold water the packing will contract slightly and cause some slippage of the pump and if the packing does not completely fill the space between the cylinder walls and the piston on which they are placed, this slight contraction of the packing will not only let the

water flow past the piston, but will allow it to flow down under the packing and if continued for any length of time will wear grooves through the packing at the joints and cut the packing out and the piston will need repacking. R. A. Cultra.

GENERATOR TROUBLE; GOVERNORS

A FIRM had trouble with its electric power, and laid it to the regulation of the engine. So a man was sent there to try to straighten out matters. The governor was examined and everything seemed to be in first-class condition. Every time they started their elevator, the hand of the ammeter moved back and forth and the lights would flicker. So a load was placed on the elevator and it was started for the top floor. The engine seemed to take it all right, but the lights flickered and became dim when the load was thrown on, and then grew so bright, it looked as if they would burn out. It was then seen that the generator belt was somewhat loose and the engineer was asked to tighten it. The generator was small, and the base narrow; a heavy pull on the belt, would tend to tip it. The under side of the belt was the tight side; when the load came on, the top side of the belt would be



MEANS USED TO STOP THE HUNTING OF A GOVERNOR

to the generator in waves, causing the generator to run unevenly. Upon tightening the belt to about what it should be, the generator was tipped. The proprietor was called, and advised to have some foundation or anchor bolts put in to hold the generator down (there were none) and the slack was taken out of the belt.

A governor on a Corliss engine, in a neighboring town, was giving trouble and a machinist was sent over to fix it. The complaint was that it raced, and the miter gears seemed to grind. A couple of new gears were taken along in case they should be needed. The governor was taken down, and it was found that the miter gear on the governor spindle was about ⅛ in. away from the shoulder of the column, causing it to bear heavily upon the other gear, breaking several teeth in the latter. The damaged gear was replaced, the gear on the spindle was moved to take up the play, and it ran all right.

We had an engine that would not hold up to speed when a load was thrown on, or off. The governor would move up and down, and would not settle to a position. So it was decided to try the method shown in the illustration. Two coiled springs were placed on the rod on the dashpot side, as shown, their tension adjusted by collars C. Lower collar cleared the dashpot cover when the governor was at its lowest point. Brass bracket B fastened on the column, by capscrew, had a slot in it, permitting the rod to slip through easily. Collars D were merely to prevent the springs from catching in, or going through the slot in the bracket. The addition of these springs made the governor steadier.

The brass heads on the governor rods should have side play, otherwise they may stick, causing the governor to work badly. Should the bore of the heads wear enough to cause much lost motion, they had better be bushed, or new heads procured. Tom Jones.

POSITION OF VALVES ON STEAM LINES

IN the discussion of the Indiana laws in regard to the location of valves in the steam outlets of boilers, Mr. O'Neill states that if the emergency valve (in his sketch) were opened first there would be no danger of water hammer, even though the riser was not drained. If these valves were always operated by a careful engineer there might be little danger, but as a rule this is not the case. Usually the boilers are cut in by the fireman or sometimes by a coal passer who may not be careful in opening the valves. The emergency stop valve will not open until the pressure is equalized, and if the water is not drawn out a serious water hammer may result.

I have in mind a plant having horizontal boiler branches valved similarly to that shown by Mr. O'Neill, except that the drain was left out. It was customary, when getting a boiler ready for service, to open the stop valve next the boiler as soon as steam was started; no nonreturn valve was used. One time this was overlooked until the pressure on the incoming boiler had reached 25 lb. and the engineer sent a coal passer up to open it. The coal passer saw no difference in the valves, and opened the nearest one, which happened to be the one next the header. The result was that the angle valve on the boiler was burst, the coal passer nearly killed, and the plant put out of operation for 2 or 3 hr.

At the present time there is a nonreturn valve next the boiler which is left open; i. e., the stem is turned up and the gate valve opened when the pressure is equal in the boiler and header. This is not the correct way to cut in a boiler with a nonreturn valve. The proper way is to open the gate valve first, run the stem up on the nonreturn valve, and it will cut itself in when the pressure is equalized. The location of the valves should be as shown by Mr. Ray on the same page, and the stop valve need not be closed except as an additional precaution when someone is working in the boiler, or during a hydrostatic test as a precaution against leakage of water into the header. If the boiler is cut in by the valve, it will be unnecessary for a man to go up on top of the hot boiler and wait for someone to tell him when to open the valve by comparing the gages on 2 boilers.

Cutting in is very dangerous, and many accidents happen at this time which would be less disastrous if the proper arrangement, and operation of the valves were used. This requirement of the Indiana law for

a valve within 18 in. of the boiler is dangerous, is bound to cause trouble, and should be changed as soon as possible. The Ohio and Massachusetts laws state: "Each steam outlet from a boiler over 2 in. (except safety valve connections) shall be provided with a stop valve of the outside screw and yoke type located as near the boiler as practicable. When a stop valve is so located that water can accumulate, ample drains shall be provided." Where the pressure is over 135 lb., 2 valves shall be used. There is no mention made in either law as to where the valves shall be placed. J. C. Hawkins.

ENGINE HOT-BOX EXPERIENCE

ON engines and other power units, the main bearings when they do run hot, may cause considerable trouble, delay and expense, part of which may be avoided if taken care of in the proper manner. One of the bad effects of a hot-box is the scoring of the shaft which requires it to be turned down, resulting not only in weakening of the shaft, but also in decreasing the surface area of the bearing box, thereby increasing the chances of the bearing box running hot in the future.

A case of hot-box recently developed in an isolated plant. Two direct connected units of 50 and 100 kw. capacity are there used for light and power. As often happens in a small plant furnishing power and light 23 out of the 24 hr. of the day, one of the engines required repairing and would be dismantled for about 2 weeks. Preparations for the repair were under way and the engine partly dismantled when the accident occurred to the remaining engine, the 100-kw. unit.

This engine had a force feed system of lubrication for the main bearing and a ring oiler in the out-board bearing. The night engineer is not only fireman as often happens in the small plants, but is also required to do night watchman work which takes him from the engine room to various outside buildings. On the way to the boiler room he examined the engine and found her working fine with all bearings cool. He was not gone 10 min. when his attention was called to smoke at the engine, by a visitor who happened along at the time. Of course, the only thing to do was to shut her down and notify the chief engineer. The chief at once started reassembling the smaller unit, for in spite of its valve trouble, it still would pull the load.

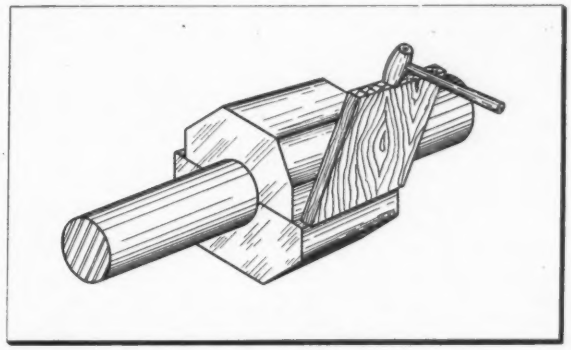
About every 5 min. the chief went over to the hot-box and turned the engine over. This performance finally got the best of the shift engineer's curiosity. "Mr. Scott, what makes you turn that engine over?"

From past experience, the chief gave the following as his explanation guaranteeing results such as he finally got in this case. After the bearing has run hot beyond any hope of cooling it to its former state the next most serious trouble is to avoid scoring the shaft.

Many engineers allow the shaft to remain at rest until the box has cooled off. In dismantling the engine, preparatory to rebabbiting the box, the shaft usually requires turning in order that the connecting rod may be disconnected. This movement of the shaft in the rough bearing causes the serious scoring. If the engine is turned over while the box is still hot and the babbit soft and this kept up at frequent intervals until the box is cooled down, no scoring or scratching will result and the shaft will be in as perfect condition as though nothing had ever happened.

In several similar cases the experiment was tried in both ways; turning the engine over until the bearing was cooled off and the other way of merely shutting down the unit. It was found that the shaft was always scored unless protected in the manner described above.

During the dismantling of the damaged unit, the machinist in charge of the work had difficulty in removing the box, the 2 parts having glued together



REMOVING A DAMAGED BOX

through the babbit. He was about to apply the torch and melt out the babbit when the chief engineer once more offered a suggestion for a better and quicker way. "All right, let's see you do it."

The method used can be best explained by reference to the figure. The lower part of the box extended beyond the upper about 1 in. A solid board of width equal to that of the box was placed on the protruding edge as shown and several good blows given it with a sledge-hammer. The bearing separated in two "slick as a willow whistle" and the shaft was just as smooth and perfect as it ever had been. F. W. Buerstatte.

VALUE OF CIVILITY

SOME time ago, being in a city of about 20,000, I entered a hardware store to purchase a pair of brackets, and while I was there a traveling salesman entered, introduced himself in a most agreeable manner as the representative of a certain wholesale hardware firm, told the merchant the class of goods they manufactured and that he would be glad to name prices and show samples of such as he handled and was short on. The merchant's answer astonished me as his rudeness and injustice were entirely uncalled for, and he certainly humiliated that salesman to the last degree. In the meantime I left the store, but couldn't help wondering how he would like it if he were treated in the same manner if positions were reversed.

But what could the salesman do? He was not there to avenge personal wrongs, he was there on business for the firm; first of all came loyalty to his employers and the mission he had undertaken; he must do nothing to hinder or bring discredit upon the interests intrusted to him, individual prejudices or resentment must be ignored for the firm's sake.

That merchant possibly made a grand mistake in not giving respectful attention as to what the salesman had to show and say, even if he finally bought little, as he would have retained his good will and that salesman would not have had a word of complaint to make against that merchant when conversing with a

brother salesman (as they frequently do), and above all the salesman might have given him pointers that would be beneficial at some future time. Civility costs nothing and maybe a lasting benefit, as the writer can testify from years of experience as a purchaser of material in large quantities. These salesmen are, as a class, live men and walk around with their eyes open and anyone failing to give them respectful attention, whether he will buy or not at that particular time, may have cause to regret it. W. S. L.

MISMANAGEMENT

THIS is a word that one seldom wishes applied to himself, and yet, how frequently the surroundings all demonstrate its presence! I am not alluding to any particular individual, however, but am writing more in the nature of a soliloquy about the different places which I lately visited while on a vacation. I first visited the state insane asylum, and perhaps should have extended my visit, yet managed to get away. I found there 3 150-hp. (rated) boilers, pulling a 50-hp. engine and generator, and a small ice machine. The buildings are built in the shape of a 3-sided hollow square, with the houses of the officers and attendants in the rear, the ice plant and laundry to one side, and other small buildings scattered about.

The cooking is done with live steam, as is the heating, and also there are bathrooms for both men and women, the water being heated with steam. Then there are 2 "unsanitary" wards with hot water from the same source. These wards are at the extreme ends of the steam mains. Steam is taken from the boilers into a 10-in. line, the boilers being located centrally, and are then taken in the 2 directions with 5-in. lines leading from a reduced tee.

Pressure is reduced from 150 lb. on the 10-in. main to 10 lb. on the 5-in. lines, each of which is 5 ft. underground, devoid of any insulating material whatever, and laid in a soil which retains moisture in such a manner that these lines practically lie in mud the year round, constituting one of the best condensers I've ever seen. Through the summer it is necessary to fire 2 of the boilers to supply the steam for cooking and heating the baths, and running the small engine and compressor. In the winter all 3 boilers are used. The coal consumption per 24 hr. during the summer averages 8 tons and in winter 15 tons, while the water evaporated in the boiler in summer averages about 5000 gal. per 24 hr. and in winter about 8000 gal. I'm not saying how this could or should be remedied, but simply ask the boys if they see any signs of "mismanagement" here?

I passed next in my travels, through a town of 3000, and found 2 lighting plants there. One had 2 fine Corliss engines and a set of turbines. The Corliss engines lay rusting out, not having been used for 4 yr. The other plant was equipped with a good set of engines (originally), and is only 18 months in service. These engines are less than 25 per cent loaded. This plant was built at an expense of $65,000 and owing to conditions of equipment already, could not now be sold for more than $8000. The main official of one is owner of the other. Has somebody "mismanaged"?

My next stopping place was way down in eastern Kansas. I found in that town a set of boilers fired with gas, and 2 75-hp. Corliss engines, one running empty, the other pulling 25 kw., and a 100-hp. Westinghouse gas engine pulling about 50 hp. On asking why one engine was running empty, and the small load divided between the other 2 engines, I was told that they didn't like to be killing and relighting their fires, and the steam engines were kept in motion to keep boilers from blowing off.

They had sudden loads coming on and off, which were more than any one of the engines could handle alone, yet the gas engine was a recent installation, and the conditions were known at the time of purchase, so why not a larger gas engine?

Journeying farther inland I reached the seaport of old Missouri, and ran aground in a little town of 3500 people, way down in the southwestern part of the state. In the lighting plant there I found a peculiar condition. They had recently burned out, without ever discovering the cause, 4 generators, and were then using one borrowed from a near-by city.

The damaged ones were placed about in various corners, no attempt being made to repair them.

One was a revolving field machine, and I stopped over 5 days and rewound it for them, at a cost of $85 outside my own and my helpers' wages. I charged for myself $50 for the job and paid my helpers out of that. The manager concluded to repair, then, instead of buying new. As for engines, they had a mixture. One old 4-valve high speed 100-hp. which they had bought secondhand for $150 was doing all their work nicely, yet there stood a 750-hp. Corliss, idle from the first week of its installation. They got it cheap, only $1500 secondhand, but good as new. Back of that stood a Westinghouse compound of 600-hp. It was run only 10 min. in that plant. The day they had intended to start it, the engineer had been scrubbing, and allowed his machine pit to fill with water, partly soaking the generator. On seeing this he bailed it out, but said nothing about it. That night the manager, owner, and a number of friends came down to see her start, and go into the harness. The manager himself started her, warmed her up, and then stepped to the board and started to build up her voltage, when zowi! out she went. She's been out ever since.

This engine was at the World's Fair and worked there, doing it so nicely that the price was asked. On being told that after the fair she could be bought cheap and on the installment plan, they took her over, thus equipping a plant with 1450 hp. for a town which can never expect to use a peak of more than 100 hp.

In the next town I went to visit the manager of the plant there, an old schoolmate. At the hotel where I put up I found the office lighted with 16 32-c.p. globes, and on asking my friend why so many in place of about 5 100-watt tungstens, I was told that the hotel was on flat rates, and that the office had to be well lighted, and that also the difference in initial cost of tungstens as compared to carbon filaments was too great. I had a letter from him only today and he tells me that he tested out both the old lamps and 5 tungstens on a meter in that particular office, and found that the tungstens not only gave better satisfaction but the consumption of the current was so much less that he had decided to install them, even before he had discovered that 5 tungstens at $1 each cost but little more than 16 carbon lamps at 25 cents each, and I'm repeating his last sentence to the boys, which was, "Can it be called 'mismanagement' or ignorance"?

John Pierce.

FUNERALS AND THE STAR FIREMAN

JACK, inscrutable Jack, was of the type of Irishmen who consume hard work like a baby does milk. But, not unlike the infant, he cared not to be perpetually consuming. He possessed the conspicuous characteristic of the Celt, that of absolutely annihilating work for a brief period after he had nursed it faithfully for a couple of weeks.

The plant where Jack kept the steam gages pointing tc 150 lb. was known to steam plant men throughout the city as the Fireman's Death House. This was owing to the fact that ordinary good firemen frequently collapsed and finally quit after a week's effort to perform their duty. Some stayed 2 weeks, but that only aided in proving to the management the superiority of the inexhaustible Jack. To hold the job down one must be a brute. If you had in your cranium any of the finer sentiments; if you knew what psychology and ethics meant, you had no business there.

The chief endeavored to remedy these conditions by installing more boilers, but he couldn't connect right with the management. So he realized that to him Jack was equivalent to 3 or 4 good boilers. But boilers as a rule don't go to the chief once in every 2 weeks to request a day off. Jack was even more considerate than boilers, however, because he would let you know when he was going. But boilers are such impulsive things. They go when you need them most, commit assault and battery on individuals and the neighborhood in general; and all this without official permission.

So, as I have intimated, Jack would bi-weekly go to the Chief asking for a day off and always giving as an excuse that a sister, aunt, brother or wife was dead and he wanted to attend the funeral. He must have belonged to an unusually large family for he never under any circumstances gave a different reason for wanting to get off. The Chief often thought this same thing but didn't want to antagonize Jack for fear of his quitting the job. One day, however, Jack came into the Chief's office with the usual request and a solemn face—a dear aunt was dead; could he go?

"Yes you can go! But good heavens, Jack! it isn't necessary to kill one of your relatives every time you want a day off." Bind.

SLOTTING THE COMMUTATOR

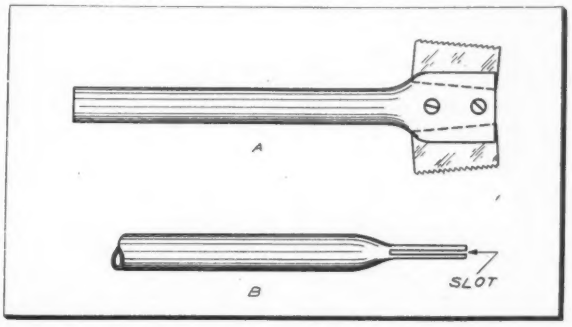
EVERY engineer or electrician that has ever been obliged to slot out the mica below the surface of the copper bars on a commutator knows that it is a mean and tedious undertaking, which is generally done with a hacksaw blade or a hook-like affair made from a hacksaw blade.

A few weeks ago I was obliged to reduce the mica between the commutator bars down below the surface of the commutator about 1/16 in. on a 1000-kw. generator; as this had to be done at night when the generator was not running, it meant speed in the slotting process in order to have it done as soon as possible.

The first night, I used an ordinary hacksaw blade wrapped on one end with tape for a handle and not getting any results worth mentioning excepting a choice lot of cuss words and bleeding hands and scratched commutator bars due to the saw blade jumping out of the slot, I decided to make the following contrivance which worked to perfection.

Take a piece of ⅜-in. gas pipe about 10 in. long and flatten one end as shown by the sketch about 1½ in. Take a hacksaw and saw the slot for the blades in between the 2 flat surfaces of the pipe as at B. Next drill and tap the flat part of the pipe for 2 10/32 screws to be used for clamping the blades in the slot. On the other end of the tool I wrapped some rags and then wrapped adhesive tape over that to make a sort of handle in order not to injure the palm of the hand when using the tool.

When ready to slot the mica in the commutator first ascertain the width of the slot and grind the hacksaw blade thin enough to cut just the mica and not



TOOL FOR SLOTTING THE COMMUTATOR

interfere with the copper bars. If the slot is wider than a hacksaw blade, two can be used by first grinding the set out of the teeth on one side of each blade before clamping them together.

The hacksaw blade should be about 1 or 1¼ in. long so that the screws in the tool will clamp them solid.

The blades can be set on an angle, as in the sketch, so that you can work over the commutator, which is not as tiresome as when having to slot with a tool that must be worked parallel with the surface of the commutator or where the outer end or handle of tool is in a straight line with the cutting edge.

C. E. Anderson.

GETTING A PRACTICAL EDUCATION

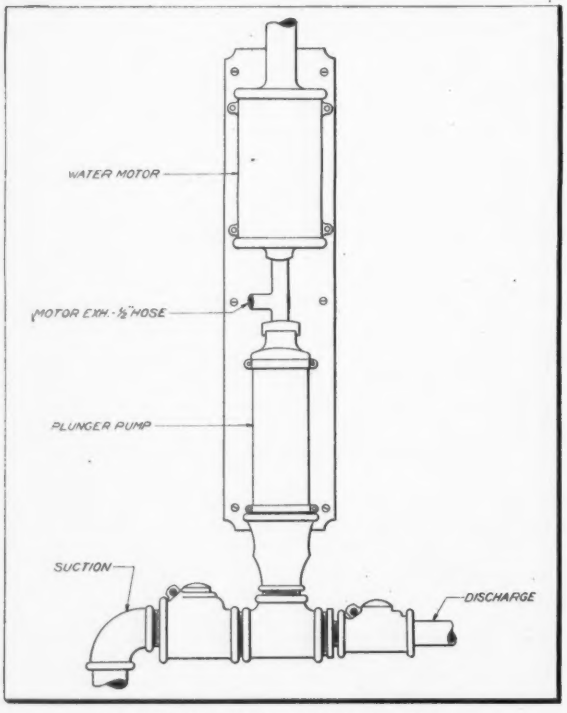
MR. HYDE in the Sept. 15 issue, gives some good advice in regard to the nontechnical engineer holding his position. There are 2 classes of engineers beside the college man. One class does not believe in books or study, and will eventually be replaced by someone who does. The other class is made up of engineers who study to keep up with the times, and who have no fear of the college man, but who can work in harmony with the technical man to the mutual advantage of both. I have an engineer friend in each class. John does not believe in books; he does not see the need of any reports or records, it is too much trouble; although in charge of a good sized plant in a factory, he gets $70 a month. He has asked several times for an increase, but for some reason has never received it. Incidentally the company finds it necessary to call in a man from the engine builder at a cost of $5 a day to put the engines in running order about every 2 months on account of the engineer's tinkering with the valves. That man need have fear of the college man if he wishes to keep his job.

Jake has about the same kind of a plant. He knows to the fraction of a cent what the heat, light and power costs are for each department, takes pride in the high evaporation of his boilers per pound of coal, and can refer to his records for anything he wishes to know along this line for several years past. If any new machinery is required the company asks for his specifications because they know that they can be depended on as correct, and places the orders accordingly. His salary is $100 a month, and the only time the engine builder sends a man into the plant is to show a prospective buyer what an excellent running machine they put out, and to get a few figures on the cost of operation which the engineer is able and willing to give. This man never attended a technical college, but he has studied, and can meet the college man on his own grounds without fear of losing his position. John says he never had a show, and does not believe in educated engineers. Jake says that he saw a chance to better himself and took it but could not have made good without his books.

J. C. Hawkins.

FURNISHING DRINKING WATER

THIS article is intended to show how an engineer can, with a little thinking, get himself out of a tight place. Some time ago I was working for a firm that thought it was costing too much for getting drinking water into the factory. The water had to be brought quite a distance, so that it required the labor of one man 10 hr. each day to supply the factory with water.



IMPROVISED DRINKING WATER PUMP

The general manager came to me and asked if it were not possible to bring the water into the factory so that the service of the man should not be required. I stated that it could be done if they would get me a steam tank pump. My reason for a steam pump was that since they wished the water to be located in the factory there was no way of using a belted or geared pump. His reply was that there must be some other way, for the company would not stand for a steam pump.

It was finally left to me to see that water was got into the factory or look for another job. Well, the sketch shows how I got the water and out of a tight place without a steam pump and at small cost to the company.

At my home I had an old washing machine water motor. I brought it to the factory, put it in good repair, then looked around the old scrap pile and found a piece of 2-in. brass pipe 12 in. long, a 2 by 1½-in. reducer, 1½-in. tee, 1½-in. swing check and 1-in. swing check valve and the cap of an old globe valve that was large enough to fit inside of the 2-in. brass pipe. I cut threads on each end of the brass pipe, one inside and one outside, then screwed the cap to one end of the brass pipe and to the other end the reducer and the tee, on suction end I put the 1½-in. check and on the discharge end the 1-in. check. I then made a suitable plunger and had a fine plunger pump.

I connected up the piston rod of the water motor to the plunger rod of pump, bolted both the water motor and pump to a board, set it up in the factory, piped my suction pipe to the well which was about 1000 ft. away, then connected up a 1½-in. line from my boiler feed pump to water motor, put ½-in. hose to exhaust pipe of water motor and run it to sewer, primed the pump, turned on the water from the feed pump and after a little priming got the pump started. It works 12 hr. each day, bringing all the water that is needed for the factory at a cost of only the price of the 1000 ft. of pipe. A little head work is sometimes needed for an engineer to hold his job when working for a firm that looks after only one end of the business.

P. H.

(While the above evidently served the purpose for which it was intended, we are inclined to question the economy of pumping water by this means. Editor).

EFFECT OF STEAM PRESSURE ON ENGINE

I NOTICED an inquiry on page 951 of the Oct. 1 issue of Practical Engineer concerning pressure in the cylinder of an engine, and a reply by R. E. T. T. H. does not say whether his engines are variable or constant cutoff.

R. E. T.'s answer is correct if they are variable cutoff engines, if they are throttling engines the strain on them would not be increased by raising the boiler pressure from 105 to 150 lb., or by running condensing, the load being constant. It takes a certain amount of pressure on the piston to do a certain amount of work and the governor regulates that.

If you were running on 105 lb. boiler pressure and increased it to 150 lb., the fly balls on the governor would swing out a little farther and throttle the steam, and the pressure in the cylinder and strain on the engine would be the same.

Wm. Carpenter.

TO ANNEAL COPPER, heat the metal to a red heat and cool it suddenly in cold water. This is the same process by which steel is hardened, and copper annealed in this way is left very soft. Hammering causes it to harden and become springy. For this reason, when working copper, so that much bending or hammering is done, the metal should be frequently annealed.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Bearing Trouble

I AM running a 150-hp. Putnam steam engine and I have to babbit the crosshead end of the connecting rod about every 4 months. I never find it hot and use plenty of good oil. The crankpin never gives any trouble. This engine drives a shaft with a water wheel that carries nearly the whole load. At times it speeds the engine up somewhat above its normal speed; would this help the babbit to wear out? Subscriber.

A. The intermittent load conditions that you are operating under are severe on the crosshead connections of an engine. As you say, the bulk of the load is carried by the water wheel and the engine is used to take care of the fluctuation of the load, and sometimes the load is too light to hold the wheel down.

You can readily see that at the beginning of the stroke, there is an impulse of steam acting on the piston; but, owing to the load being carried mostly by the water wheel, at some point towards the end of the stroke, the steam expands down below back pressure, when the piston, to all intents and purposes, is being carried by the water wheel and used as a compressor.

This intermittent action where there is an oscillating motion (instead of a rotating motion the same as at the crankpin) causes a rapid deterioration of the babbit, especially so if it is of a comparatively soft nature.

Practically all engine builders of today use a phosphor bronze box at the crosshead end of the rod. The writer had a trouble similar to yours in some respects. The crosshead pin boxes were of a material called lumin bronze, which had a high coefficient of expansion. The engine was a tandem compound with shaft governor, direct connected to a 150-kw., d.c. generator.

Scarcely a week went by without some trouble with the box. Finally new ones of phosphor bronze were made and installed and the box was not even taken up during the next 6 months. Of course, bronze boxes are expensive at first cost, but they save in shutdowns and overtime.

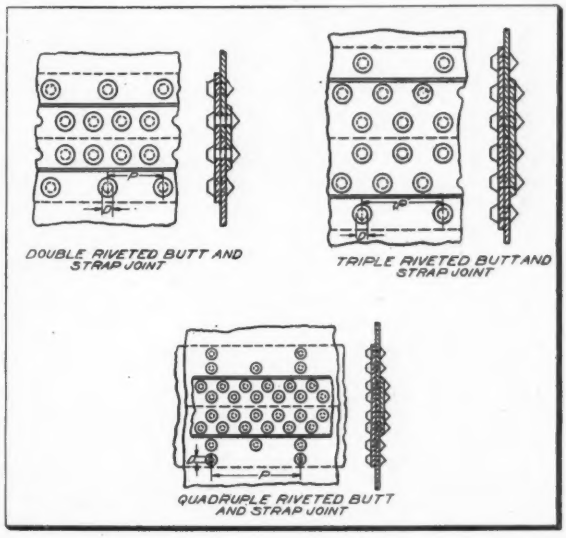
As to trying a different babbit, there are so many different brands of babbit peculiar to the several sections of the country, that it would not be possible to mention a good babbit for your case, only that there is a babbit called "Gas Engine Crankpin Babbit," which is used extensively by manufacturers of automobile and other gas and gasoline engines. This babbit costs in the neighborhood of 70 ct. a pound.

"Parsons White Metal," to be had in this country only from Cramp's Shipbuilding Co. of Philadelphia, is an excellent metal for such conditions as you have to meet. It must be scraped to an absolute fit or it will heat. Do not expect it to wear down if scraped to about half a bearing, but scrape it absolutely perfect, and you have a satisfactory job that will last as long as the engine. G. H. Wallace.

Efficiency of Boiler Joints

WHAT is the correct way to figure the efficiency of double, triple and quadruple riveted butt and strap joints? Also, let me have sketches of double and quadruple riveted butt and strap joints, front and side view. C. B. A.

A. In figuring the efficiency of a riveted joint, the least possible resistance or force of rupture must be calculated, in various possible ways. This amount divided by the strength of boiler plate for an equal length, is called the efficiency of the joint.



TYPES OF BOILER JOINTS

In double, triple and quadruple butt and strap joints, properly designed, failure should first occur at the outer row of rivets, by tearing of the boiler plate. With this in mind, the efficiency can be easily figured by the formula:

$$P - D \div P,$$

in which P stands for the pitch at outside row of rivets, and D stands for the diameter of driven rivets.

Care should be exercised in the proper designing of the joint, or failure may occur in some other way than tearing of the plates at the outer row of rivets, as, for instance, the shearing or crushing of rivets, and in that case the above formula would not apply.

F. W. B.

THE CUERO (TEX.) LIGHT AND POWER CO. expects to build a new dam and power house several miles below the present dam to afford more power than is at present available. Also, about the first of the year a large steam plant will be erected in the city to take care of the patrons in times of high water.

General Power Plant Questions

HOW much water will 1 lb. of coal evaporate?

2. A pump is 3 in. in diameter, 12-in. stroke, runs 25 strokes per minute; how many cubic feet of water will it throw per hour, pump ¼ full?

3. Find the safe working pressure on flat bottom boiler.

4. If you had a boiler with 2 furnaces each 6 ft. by 3 ft. what would be the diameter of the safety valve?

5. What would be the tensile strain on a piston rod, piston 36 in. in diameter, steam pressure 100 lb. by gage, 26-in. vacuum.

6. A 3-in. check valve has a 45-deg. bevel seat, what lift should it have?

7. How would you determine if your cylinder was in line with the crank shaft, vertical engine?

8. How many pounds of water are required per I. hp. for a single engine, also a triple expansion?

9. What is the advantage of forced draft over natural?

10. How many inches of friction surface are in a journal 16 in. diam., 28 in. long?

11. Diameter of feed pump 6 in., length of stroke 10 in. what is capacity of pump?

12. Why is it important that shaft bearings should be sufficiently large?

13. What is the advantage if any between a simple engine and a triple expansion, both working at same steam pressure and ratio of expansion?

14. Sketch an indicator card from condensing engine and give rule for finding horsepower.

15. Which is the stronger, a single or double butt strap joint and which requires less rivets?

16. Diameter of cylinder 36 in., pressure 100 lb., vacuum 26 in., find diameter of piston rod required.

17. 50 lb. steam, piston 6 in., water piston 3 in., how high can you force water?

18. Sea water 60 deg., hot well 110 deg., how many pounds of cold water is required to condense 1 lb. of steam?

19. Sketch indicator card from a noncondensing engine cutting off at half stroke so as to show lack of steam and exhaust lead, too small steam port and leaky valve.

Subscriber.

A. The amount of water that a pound of coal will evaporate depends on the temperature at which the water comes into the boiler, the pressure at which the steam is formed, and the kind of coal used.

Assuming that your water enters the boiler at 100 deg. F., and that you are making steam at 125 lb. boiler pressure. From the steam tables, the total heat at 125 lb. is 1192.2 B.t.u. The heat in the water at 100 deg. F., from the steam tables, will be 68 B.t.u., so that each pound of water will take up 1124.2 B.t.u. in the boiler. A pound of bituminous coal from New River, Virginia, region, may be taken as having 15,000 B.t.u., so that one pound would evaporate 15,000 ÷ 1124, or approximately 13.35 lb. of water. This, of course, does not allow for the loss in heat in the furnace and boiler. A combined boiler and furnace efficiency of 60 per cent would be very good practice, which would give an actual evaporation of 0.6 × 13.35, or 7.95 lb. of water per pound of coal.

2. We do not understand what you mean by a pump ¼ full. Any reciprocating pump, except the vacuum pump from a surface condenser, will run more than ¼ full or not work. If the pump had a full cylinder of water each stroke, the cubic feet of water per hour would be found by multiplying the square of the radius of the piston by 3.1416, by the length of the stroke in inches, and by the number of strokes per hour, and dividing by 1728. In your case this becomes,

$$\frac{3.1416 \times 152 \times 12 \times 25 \times 60}{1728}$$

or 74 cu. ft. approximately.

3. It is impossible to know the safe working pressure on a flat bottom boiler unless you know the thickness of the plate, size of the boiler, and the way in which it is stayed. No flat bottom boiler would be used for anything but low-pressure heating without staying.

4. Determining the size of a safety valve from the grate surface alone is not good practice, and should not be permitted. The Massachusetts Board of Boiler Rules, in its catalog, gives the following figures: For a safety valve, not spring loaded, pressures 50 to 100 lb., a 4-in. valve will take care of 28¼ sq. ft. of grate; 3½-in. valve, 21¾. Your boiler would have 36 sq. ft., which would require a 4½-in. valve. If the valve is spring loaded, with the same pressures between 50 and 100 lb., a 4-in. valve will take care of 42½ sq. ft.; a 3½-in. valve, 32½ sq. ft. It would be necessary, therefore, to use a 4-in. valve.

The size of valve should always vary with the pressure at which it is to be used. For instance, the Board of Trade Rules for Marine Work gives for 50 lb. pressure, 0.576 sq. in. per sq. ft. of grate area; for 100 lb. pressure, 0.326 sq. in.; for 150 lb. pressure, 0.227 sq. in.

5. The total strain on a piston rod is found by multiplying the area of the piston in square inches by the difference in pressures between the steam and exhaust sides, in pounds per square inch. The 26 in. vacuum is equal to 12.74 lb. below atmosphere, so that the difference in pressures would be 100 + 12.74, or practically 112¾ lb. per square inch.

The area of the piston is found by multiplying the square of the radius by 3.1416. For a 36-in. piston, this would be 1018 sq. in. The total pressure would then be, 112¾ × 1018, or approximately 113,600 lb.

6. The area under a check valve will be the distance between faces times the circumference, and this should equal the area of the opening of the valve. For a 45-deg. bevel, the distance between surfaces is equal to the lift divided by 1.41. The circumference is equal to 3.1416 times the diameter, and the area of the opening is equal to 3.1416 times the square of the radius.

To find the lift, we should then multiply the area by 1.41 and divide by the circumference. In your case, the area is 3.1416 times 1.5^2; this is multiplied by 1.41 and multiplied by the circumference, which is 3.1416 × 3. The lift would then be 1.06 in., in order that there may be the same area around the circumference of the valve that there is through the opening. This is, of course, for a straight lift valve.

7. If your vertical engine is set accurately, with the cylinder vertical, the easiest way to determine whether it is in line with the shaft is to put a stick across the upper end of the cylinder, locate the center of the cylinder accurately on this stick, and drill a fine hole through, then drop a plumb line through this hole. If the cylinder is in line, the point of the plumb bob will come exactly over the center of the shaft, and if you caliper to the line from the lower end of the cylinder, the line will hang central in this lower end.

In case the cylinder is not vertical, instead of using a plumb line, stretch the line from the upper end of the cylinder so that it will come through the center of the shaft, and caliper to see if it is central with the lower end of the cylinder.

8. The pounds of water required per horsepower hour for an engine, will depend on the type used. For a high speed, single cylinder engine, a reasonable steam consumption is 50 lb. per horsepower-hour; for a Corliss single cylinder, 30 lb.; for a high speed, triple expansion, 25 to 30 lb.; for a Corliss triple expansion, 12 lb.

9. The advantages of forced draft are, first, the lower investment cost for the draft plant than would be the case if chimney draft were used, and greater flexibility in the draft; that is, the draft can be varied quickly to suit the load on the boilers, and over a wide range.

10. The friction surface in a journal is found by multiplying the circumference of the shaft by the length. For a 16-in. shaft, the circumference is 50.27 inches, and the length that you give is 28 in., giving a surface of 1410 sq. in.

11. The capacity of a feed pump is usually given in gallons per stroke. There are 231 cu. in. in a gallon, so that we should find the volume of the pump cylinder in cubic inches, and divide by 231. The area of a 6-in. plunger is 28.27 sq. in.; multiplying by 10 gives 282.7 cu. in., dividing this by 231 gives 1¼ gal. approximately.

12. If a shaft bearing is not large enough to carry the weight, and pressure, it is likely to heat up, and also it will be necessary to use a heavy lubricant, which will mean a greater loss in power due to the friction.

13. The triple expansion engine has a less loss from condensation of steam, and less amount of live steam required to fill the clearance spaces, and as it has 3 cranks, spaced at 120 deg. apart, the turning effect is much more even than where all the power is applied to a single crank as in a simple engine.

14. The method for finding the horsepower of a condensing engine is no different from the noncondensing. From the indicator diagram, find the mean effective pressure in pounds per square inch; then multiply this by the length of the stroke in feet, by the area of the piston in square inches, and by the number of working strokes per minute, and divide by 33,000. An indicator card from a condensing engine would be as here shown.

15. The double butt strap joint is stronger and requires fewer rivets. The single butt strap joint is no stronger than a lap joint, and takes the same number of rivets as the lap joint.

16. The data here is the same as for the fifth question, and the total pressure to be carried by the piston rod is 113,600 lb. Assuming the tensile strength of the rod as 60,000 lb., and a factor of safety of 10, would give as the safe working strength, 6000 lb. per sq. in.; dividing the total pressure by this, gives an area of 18.92 sq. in., and from the table of area of circles, the nearest diameter of rod would be 5 in., which is an area of 19.64 sq. in.

17. To find the height to which a pump can lift water, multiply the area of the steam piston by the steam pressure, divide by the area of the water piston and multiply by 2.31, as one pound pressure will lift water 2.31 ft. The area of a 6-in. piston is 28.27 sq. in.; multiply by 50 lb.; divide this by the area of the 3-in. piston, which is 7.07, and multiplying the quotient by 2.31 gives 46.15 ft. lift.

18. The number of pounds that can be condensed by a pound of water raised from 60 deg. to 110 deg., depends on the pressure at which the steam is condensed. If we assume that the steam comes to the condenser at 26 in. vacuum, the heat to be taken out in order to condense it will be 1026.9 B.t.u. per pound. The steam would be at 125.5 deg. F., and would be cooled down to 110 deg., thus giving up 15.5 B.t.u. after it became water. This added to the 1026.9 gives 1042.4 B.t.u. to be taken out of each pound of steam. Each pound of water will take up 110 minus 60, or 50 B.t.u. Dividing the heat taken from a pound of steam by the heat taken up by a pound of water, we get 20.85 lb. of water to condense a pound of steam.

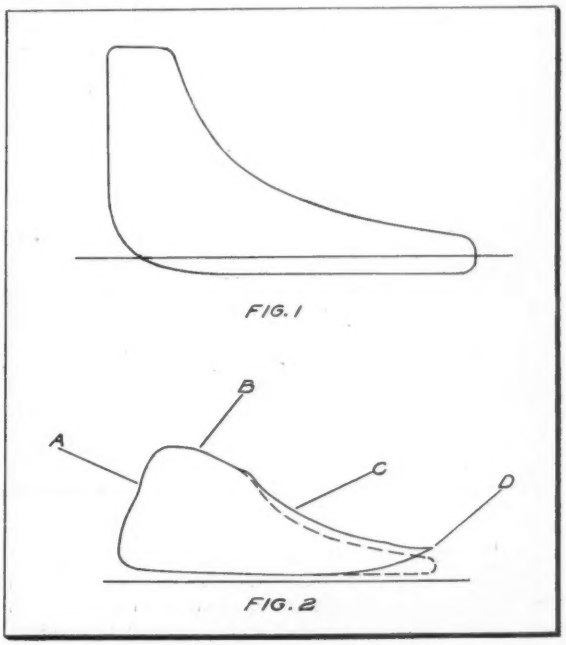


FIG. 1. REPRESENTATIVE INDICATOR CARD FROM A CONDENSING ENGINE

FIG. 2. CARD SHOWING LATE ADMISSION AND RELEASE, LEAKY STEAM VALVE AND TOO SMALL STEAM PORTS

19. The indicator card having the characteristics specified would be as shown herewith. The lack of steam lead is shown by the curving forward of the admission line A. Small steam port is shown by the dropping off of the steam line B, which should hold up horizontally if the port were sufficiently large. The leakage of the steam valve is shown by the flatness of the line C, which should have greater curvature due to expansion, as indicated by the dotted line, if the valve were tight. The late exhaust is shown by the toe D, which should, of course, drop to back pressure quickly, as shown by the dotted line, if the valve opened as early as it ought. A. L. R.

IT IS A CURIOUS fact that when seventy per cent of cerium is alloyed with thirty per cent of iron, the metal thus produced possesses the remarkable property of giving off a shower of sparks when struck lightly by a steel wheel. This substance has been used for making autoigniters for gas burners, miners' acetylene lamps and cigar lighters. It has been proposed to utilize it for igniting motor headlights, and even to employ it as a substitute for electric ignition in the cylinders.—Penberthy Engineer and Fireman.

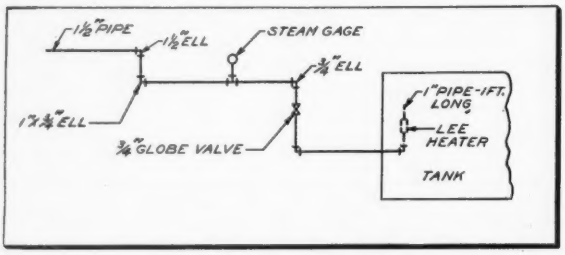
Steam Flow; Gage Connections; Cable Strength

I HAVE a tank on the roof which holds 25,000 gal. of water; it is 18 ft. diameter by 16 ft. deep. In winter I heat it so it won't freeze. I have a ¾-in. pipe that enters at the bottom through a 1-in. Lee Pinhurt heater; on the end I have 1-in. pipe, 1 ft. long, for discharge. How much steam will flow through it, or how many pounds of steam per hour through the ¾-in. pipe, steam pressure at tank, 75 lb., the ¾-in. valve is wide open?

2. I have a 6-ft. by 14-ft. return tubular boiler, with 84 3½-in. tubes; the water column connections are 1¼-in.; gage glass cocks are ¾-in. I wish to put on a pair of Graber self-closing cocks, of Jenkins Bros. make. Would it make any difference if I bush them down to ½-in. fittings and ½-in. glass, instead of ¾-in. fittings and ¾-in. glass?

3. Will you figure out, in arithmetic, an example so I can see how the safe load on an elevator cable is figured? We have ½ by ⅝ by ¾-in. cables. I do not know whose make they are. Does one rule apply to all sizes of cables? R. E. K.

A. We are unable to find any data relating to the velocity with which steam of any pressure will flow from a submerged pipe into water.



STEAM PIPING TO TANK

In the example given the steam flows to the water through a Lee heater, which will tend to produce the same effect on the steam that obtains in the injector. The steam flows into a vacuum produced by its condensation, and I assume that the rate of flow will approximate that given in the formula for the flow of steam from an orifice into the atmosphere.

$$W = \frac{ap}{70}$$

in which W = weight of steam flowing per second,
a = area of orifice,
p = absolute pressure per sq. in. of steam.

Substituting numerical values in the equation and solving,

$$\frac{0.049 \times 90}{70} = 0.063 \text{ lb. steam per second,}$$

$0.063 \times 3600 = 226.8$ lb. steam per hour.

2. Half-inch thread gage cocks and glass fittings may be substituted for ¾-in. with perfect safety, and are commonly used on the smaller sizes of boilers.

3. No intelligent estimate of the proper working load of an elevator cable can be made without knowing its structure and ultimate strength, for according to the material and number of wires some cables are more than 3 times as strong as others of the same size.

Besides the calculated load, the bending of the cable around the sheave introduces a stress which must be taken into consideration.

To calculate the working load the breaking strength must be known and also the bending stress. Then take the ultimate strength from the tables in the manufacturer's catalog, divide this by 5 and from the quotient subtract the bonding stress for the maximum working load.

For example: What is the proper maximum working load for a ¾-in. mild steel elevator cable of 6 strands with 19 wires to the strand, running over a sheave 3 ft. in diameter, using 5 as a factor of safety?

Catalog strength =	13.5 tons.
13.5 ÷ 5 =	2.7 "
Bending stress for 3-ft. sheave =	1.6 "
Maximum load =	1.1 "

Scale in Boiler

I HAVE a water-tube boiler, an Erie City, which is scaled badly with a thin, hard scale. I have used 3 kinds of boiler compound, and boiled out the boiler with about 20 lb. of soda ash, and have made scrapers of different kinds and I can not remove the scale. We are using Lake Michigan water. H. B.

A. Your scale troubles ought not to be difficult as the water from Lake Michigan is not a difficult water to deal with in steam boilers. As to compounds, there are compounds advertised in Practical Engineer, which will meet practically every condition that may arise in the way of scale in boilers.

You will appreciate the fact that no matter what the qualities of any particular compound may be, there sometimes arises a case that for some reason or other seems to defy scientific treatment by it.

Cases of this kind require concentrated thought and study. The writer had an experience once with Lake Michigan water that for a time seemed puzzling, and several experiments were tried out, each a little better than the preceding, till perfection was reached.

There were 2 300-hp. horizontal water-tube boilers which had a rapid circulation and a large settling chamber in the bottom of the rear tube manifold, also a purifying pan in each drum of each boiler.

After a number of trials and inspections we finally stopped at the following as giving as good results as could be desired: 10 lb. of caustic soda, 5 lb. brown sugar, 4 lb. of tannic acid. Mix in about 40 gal. of water and stir till dissolved. (We used a small air jet for the purpose.)

We used a pint of this mixture 3 times a day, morning, noon and 6 p. m., the boilers being under steam 16 hr. a day at full capacity or more. This pint of the mixture was put in another receptacle holding about 50 gal. and filled with water and a small valve opened so as to empty in about 5 hr. This second weak solution drained into the pump receiver by gravity and from there to the boiler through an open heater.

The boilers were blown at 4 a. m. after being at rest about 6 hr. The blowoff valve was opened and closed at once, just enough to take away the settlings in the bottom of the rear manifold and not draw too heavily on the cleaner water in the boiler.

We washed every 4 weeks, with water at about 120 deg. and 100 lb. pressure, which took off all of the scale which was so soft that it could be crumbled in the fingers. Every 6 months an ordinary cone shaped fire tube scraper was run through each tube and it was then as clean as a new one.

I will say, however, that we had a certain amount of return water from the factory proper, and in the winter, from the heating system as well.

G. H. Wallace.

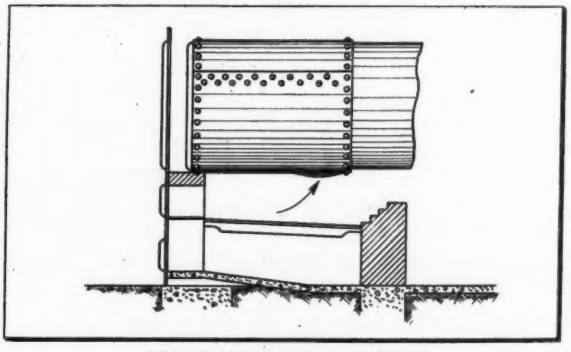
Bagged Boiler; Capacity of Feed Pump

OUR boiler is bagged down about ¾ in. over the fire or close to the bridge wall. It has been driven back 3 times, they told me, and 2 or 3 holes have been drilled in it for rivets. The boiler is 60 in. by 16 ft. Is the boiler safe to run that way? The steam pressure is 115 lb. and has not been inspected.

2. How can I determine how large a pump will be required for any certain plant which may be put up? A. L. J.

A. It is not safe to continue such a plate in service—the life of the metal is exhausted. The fact that this plate has made its fourth pilgrimage downward warrants a radical change in the method of cleaning the boiler.

2. A boiler feed pump should be figured to take care of the maximum possible demand upon it when running at a moderate speed. Each boiler horsepower is supposed to call for 30 lb. of water an hour, or approximately a half cubic foot, or about 4 gal.



LOCATION OF BAG IN BOILER

Practically any modern boiler can be run at twice its rated capacity, so that to get the pump capacity required, multiply the boiler horsepower by 2 and then by 4, and it will give you the pump capacity in gallons per hour. The pump should not be run faster than 50 strokes, or 25 double strokes, a minute.

The pump makers' catalog will, in all cases, give you the gallons capacity at about this speed.

Boiler Furnace for Wood

WILL you kindly advise us what you consider the best setting for a horizontal return-tubular boiler, 78 in. by 20 ft., to carry 130-lb. pressure and to burn 4-ft. wood, slabs and edgings?

What we desire is the best distance to place the boiler above the grates and also the distance from the boiler shell to the bottom of the combustion chamber and from the back head to the rear wall of the setting. This boiler has 86 4-in. tubes. E. H.

A. There have been a good many different plans put forward as the best for wood burning. On analyzing them, the essential features of success are ample combustion volume and a proper arrangement of the grates so that the incoming air shall not bypass or escape to the chimney without having served its purpose in supplying oxygen for combustion. Some users have found it desirable to slope the sides of the furnace walls to a considerably narrower grate than the width of the boiler, thus compacting the fuel.

Others have secured the same draft conditions by blocking off the sides of the grates and in some cases it has been found desirable to block off the rear end of the grate near the bridge wall. These different arrangements depend largely upon the intensity of the draft. If the draft is very strong, it is quite evident that a smaller grate area, at the front end of the furnace, would bring the travel of the air to the best location for combustion.

Not knowing the height of your chimney nor the intensity of the draft, we are unable to advise regarding these items, but for the height of the shell from the grate we would advise a setting of 4 ft. or 4 ft. 6 in. between the grate and boiler shell with the bridge wall sloping up at an angle of about 30 deg. with the vertical to within about 18 in. of the shell. The combustion space back of the bridge wall need not be more than 3 ft. deep from the shell to the floor. The space between the rear of the boiler and the back wall should be made about 3 ft., this distance having considerable to do with the matter of friction to the passing of the gases. If it is made too short, the gases have to turn sharp angles and bank up into quite an obstruction. In the matter of doors in the furnace front, it is desirable to make them in 2 tiers. The upper for firing the wood and the lower for raking the grates. The lower ones might advantageously be made 12 in. high and the upper ones 18 in. or 2 ft.

Radiation From Steam Pipe

HOW do you figure the loss per hour due to radiation of an uncovered steam pipe 2½ in. in diameter and 225 ft. long, if the steam pressure is 100 lb. and the average temperature of the air is 60 deg. F.? How much coal can be saved per hour? J. L.

A. Temperature of steam at 100 lb. gage, 338 deg. F. Difference in temperature between steam and air, $338 - 60 = 278$ deg. F.

Heat units radiated an hour per square foot of surface for 1 deg. F. excess in temperature of steam above air, for common steam pipe, 0.64.

Area of 1 ft. length of 2½-in. steam pipe $= 2\frac{1}{2} \times 3.1416 \div 12 = 0.66$ sq. ft.

Newton's law for radiation states that the loss in heat units per lineal foot is equal to the continued product of the difference in temperature between the steam and the air, the area in square feet of 1 ft. length of pipe, and the heat units radiated an hour for 1 deg. F. excess in temperature of steam above surrounding air.

We then have for loss per lineal foot of pipe, $278 \times 0.66 \times 0.64 = 117.43$ heat units. $117.43 \times 225 = 26{,}721.75$ heat units total loss per 225 ft. length of pipe.

One horsepower = 33,000 ft. lb. per min. = 2545 heat units per hour.

Loss in horsepower by radiation $= 26{,}721.75 \div 2545 = 10.4$ hp.

The question, "How much coal can be saved per hour?" we take to mean, what would be the saving if pipe covering is used? From tests it has been determined that the saving due to covering in pounds of steam an hour per foot is as follows:

Magnesia, 0.726; rock wood, 0.766; mineral wool, 0.757; fire-felt, 0.689; Manville sectional, 0.737; Manville sectional and hair-felt, 0.780; Manville wool-cement, 0.728; Champion mineral wool, 0.747; hair-felt, 0.714; Riley cement, 0.548; fossil-meal, 0.571.

In the pipe line in question, there are 148.5 sq. ft. of surface; assuming magnesia pipe covering to be used, the saving in steam would be $148.5 \times 0.726 = 107.8$ lb. At 30 lb. per hp.-hr., the saving in horsepower would be $107 \div 30 = 3.59$. Assuming a coal consumption of 4 lb. per hp.-hr., the saving in coal would be 14.36 lb. an hour.

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CONTENTS

A District Power Supply. Illustrated....1077
Superheating and Superheaters. By Sterling H. Bunnell....1082
Flanges and Flange Fittings....1083
Heating and Ventilating Large Buildings. By Charles L. Hubbard. Illustrated....1084
Curtis Steam Turbine. Illustrated....1087
Practical Electrical Engineering. By Norman G. Meade. Illustrated....1090
Trouble with Paralleling. Illustrated....1093
Meter Error....1094
Foreign Development in the Power Plant Field. By J. H. Blakey. Illustrated....1095
Power Plant Chemistry....1096
Peculiar Scale Formation. By C. W. Dunlap. Illustrated....1097
Uniflow Engines....1097
Improving Combustion in Small Plants. By W. H. Odell....1098
A New Type of Suction Gas Plant. Illustrated....1099
Gas Engine Cards. By N. A. Nabal. Illustrated....1100
Training for Gas Engineers. By G. W. Muench....1100
Letters Direct from the Plant: Poor Packing Breaks Follower. Generator Trouble; Governors. Position of Valves on Steam Lines. Engine Hot-Box Experience Value of Civility. Mismanagement. Funerals and the Star Fireman. Slotting the Commutator. Getting a Practical Education. Furnishing Drinking Water. Effect of Steam Pressure on Engine. Illustrated....1101
Questions Answered and for Answer: Bearing Trouble. Efficiency of Boiler Joints. General Power Plant Questions. Steam Flow; Gage Connections; Cable Strength. Scale in Boiler. Bagged Boiler; Capacity of Feed Pump. Boiler Furnace for Wood. Radiation from Steam Pipe. Illustrated....1107
Editorial: Time to Wake Up....1112
News Notes....1113
Western Stationary Engine. Illustrated....1114
"Keystone" a Valid Trade-Mark....1115
Elliott Vertical-Cylindrical Heater. Illustrated....1116
Practical Reference Tables: Standard Pipe Dimensions; Extra Heavy Pipe Dimensions; General Dimensions of Standard Flanged Fittings....1117
Progress of the Panama-Pacific Exposition....1119
Books and Catalogs....1119
Trade Notes....1120

TIME TO WAKE UP

In the interests of exhibitors at the Panama Exposition who will send exhibits from foreign countries, Congress has recently passed a law which is so worded that it is not only likely to work great injury to many a manufacturer, but is almost sure to be made the tool of tricksters, and blackmailers to hamper American industry. The first section provides simply for the free entry of goods furnished for the Panama Exposition, and is unobjectionable. The other provisions of the bill are, that "the proprietor of any certificate of registration, copyright, trade-mark, or patent, issued by a foreign government protecting any pattern, model, design, copyright, trade-mark or manufactured article, imported and exhibited, may, upon presentation of satisfactory proof of such proprietorship" obtain a certificate from the branch office of the Librarian of Congress and the Commissioner of Patents to be established at the exposition, a certificate which is registered, and at the close of the exposition, deposited in the patent office at Washington. The bill goes on to state, that the person who copies, imitates, reproduces or republishes any pattern, design, copyright, or manufactured article, protected by the laws of any foreign country, by registration, copyright or otherwise, which shall be imported for exhibit at the Panama-Pacific International Exposition, shall be held to infringe on the right of the proprietor, and goes on to specify the penalties by which such an infringement is to be punished.

Unfortunately, many foreign governments issue patents, trade-marks, and copyrights, without examination of the novelty, originality, or scope or ownership of the special pattern.

It would, therefore, under the provisions of the law just passed, be possible for any foreigner, or for that matter, for an American, to register with a foreign government, a design of textiles, or of any manufactured article, which was a plain copy of articles made in America, to send such registered articles to the exposition and register them under the special act, and then, by virtue of this bill, to prevent the original American manufacturer from making his own product during the period of 3 yr. In effect, the law makes it possible for any foreign government to grant to anyone a patent protecting him in the United States during the period of 3 yr. without regard to our own patent laws, and makes our citizens liable for infringing any alleged rights of any foreign manufacturer under a registration of his patent in his own country. This feature of the bill is dangerous, and carries opportunity for great confusion and great injury to the manufacturers of the United States. It should be amended so that the objectionable provisions are eliminated, or have power for harm annulled. The act is entitled H. R. 7595, Providing for the Free Importation of Articles Intended for Foreign Buildings and

Exhibits at the Panama-Pacific International Exposition, and for the Protection of Foreign Exhibitors. It would be well for any manufacturer of any article of special design, to get a copy of this bill and study its provisions and then act to protect his own interests in the matter.

NEWS NOTES

ELGIN, ILL., AUTHORIZED A BOND ISSUE of $162,000 recently, to build an electric light plant.

AN ELECTRIC LIGHT PLANT for Whitesburg, Ky., is practically assured. Ira Fields, Jr., and others of Harlan, Harlan County, are laying plans for the early installation of the plant.

PLANS FOR THE NEW electric light plant for the village of Manito, Ill., have been agreed upon and the blueprint of the structure is now being made. Reeves and Baillie of Peoria are the architects.

DAN CUBBERLY, for many years with Geo. B. Carpenter and Co., has been made vice-president of the Julius Pearse Fire Department Supply Co., 304-305 Jacobson Building, Denver, Colorado, and will devote his time to the Eureka line of fire hose.

THE PUBLIC SERVICE COMMISSION has issued an order granting permission to the Northern New York Utilities, Inc., to construct and operate a hydro-electric plant on the Beaver River near the hamlet of Belfort, Lewis Co., N. Y.

SAUER & HAHN are preparing plans and specifications for a mill building and power plant to be erected on Main St., Manayunk, Philadelphia, for A. T. Baker Co., Main and Carson St., Manayunk. The new building will be 4 stories, 70 by 200 ft., and constructed of reinforced concrete with metal sash.

WORK WAS STARTED RECENTLY at the Scott, Pa., colliery at excavating for the erection of a big central power plant. The new plant will be a cement block building. This plant, when completed, will be one of the largest power plants in the region. It will supply power to Hickory Ridge, Pennsylvania, Richards and Scott collieries.

THE C. & C. ELECTRIC & MFG. CO., of Garwood, N. J., announces the following additions to its sales staff: Robertson-Cataract Electric Co., 37 Court Building, Buffalo, N. Y.; The Gurley Engineering Co., Ellsworth Building, Chicago, Ill.; F. L. Robbins, Grubb Building, Salisbury, N. C.

DIRECTORS OF JONESBORO, ARK., State Agricultural College have decided to rebuild at once the power plant destroyed by fire recently. A rough sketch of the proposed building already has been made. Arrangements have been made with the city light company to furnish lights until the plant can be rebuilt. A temporary heating and water service will be arranged at the college.

AT ALBANY, MO., a contract has been awarded for the installation of improvements at the electric power house. All machinery to be installed is to be the best and latest obtainable, including a heavy duty, 150-hp. Murray-Corliss engine, the best generator that could be obtained, a Blake-Knowles 400-hp. heater, a 400-hp. boiler feed pump in addition to the one in use, Murray Iron Works 150-hp. boiler complete with full shaking grates, steam traps and steam separators, 4-panel switchboard with full equipment.

ON OCTOBER 20, Frank E. Getts took charge as district sales manager of the Chicago Office of the Alberger Pump and Condenser Co., of New York. At the time of his appointment to this position Mr. Getts was engineer in the Chicago office of the General Electric Co., and in connection with important steam turbine installations is well known throughout the United States.

A NEW FIRM has been incorporated under the name of the Thomas C. Warley Co., which is entirely independent of the old Thomas C. Warley & Co., although both firms will be located at 221 South Front St., Philadelphia. The officers of the new firm are E. A. Tygert, president; H. Bentley Smith, vice-president and general manager; and E. Wilson, treasurer. The new firm will make a specialty of lubricants.

RECENTLY, a notable meeting of big electrical men was held at Association Island in Lake Ontario, to discuss the advancement of the electrical industry as a whole.

Samuel Insull, of the Commonwealth Edison Co., Chicago, spoke of past and present methods of distribution, and stated that the central station is changing from a lighting business to a power business. He showed that by energetic pushing to secure power load, the load factor has in some cases been raised from 30 per cent to about 45 per cent. He stated that over 25 per cent of the kilowatt output of his company is consumed in lighting load, but that 47 per cent of its total income is derived from the lighting load.

Dr. C. P. Steinmetz, speaking of future development, stated that while 30,000-hp. is the present largest generator, larger units will be built when there is demand for them. Electrical transmission is now carried at 140,000 volts over a distance of 200 miles, covering from 10,000 to 20,000 square miles, so that the interlinking of great transmission systems is decidedly possible for the future.

In the discussion of public utility corporations, it was shown that present development favors the principle of the franchise revokable at any time, with the provision that the community must pay, to the holder of the franchise, what a reliable commission determines to be the correct value of the property. Also, it was estimated that $8,000,000 a week of fresh capital, or $40,000,000 a year, could be profitably used for the next 5 yr. in development of the use of electrical energy in the United States. In order to get this amount of capital, it is necessary to educate the investors as to the stability of the business and the certainty of a steady, fair return on capital used by public utility companies.

Senator Howland, of Massachusetts, stated that any company which was operated with the idea of giving the public the best service at a fair remuneration for the capital employed, would have nothing to fear from government ownership or oppressive regulation.

The Society for Electrical Development, which is organized for broad effort in promoting and popularizing electrical service, was a prominent topic of discussion, with the certainty in sight that it will soon be ready to do business by preparing articles and advertising for popular magazines, and advertising copy for local dealers, and by the preparation of motion picture films, showing the use of electrical apparatus.

The thought behind the Society is to assist manufacturers of electrical machinery and devices in the sale of their goods, and to assist the electric companies in providing a market for their current.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

WESTERN STATIONARY ENGINE

Use of Water Vapor in Gas Engine Reduces Its Weight and Initial Pressure Without Reduction in Power

TO overcome the severe strains upon the piston, connecting rod and crankshaft as well as to reduce the size and weight of the flywheel, the Western Gas Engine Corporation of Los Angeles, Calif., injects water vapor with the fuel into the cylinder. By this simple expedient the water vapor is flashed into steam at the time of the explosion. This change absorbs heat from the gases, thus reducing the peak in the pressure at the beginning of the stroke, which is given up as power as the steam and gases expand later in the stroke.

Low grade fuels, even to 38 gravity tops or toppings, it is claimed, can be burned in Western engines without gumming up the valves and causing other troubles. This feature effects considerable saving in the cost of fuel.

Comparison of the accompanying indicator cards illustrates the effect of the water vapor in the cylinder. These cards were taken from an engine under similar conditions, No. 1 without water vapor and No. 2 with water vapor; the former has 300 lb. initial pressure and an area of 1.82 sq. in., the latter has an initial pressure 14 per cent less and an area 9.89 per cent greater than No. 1.

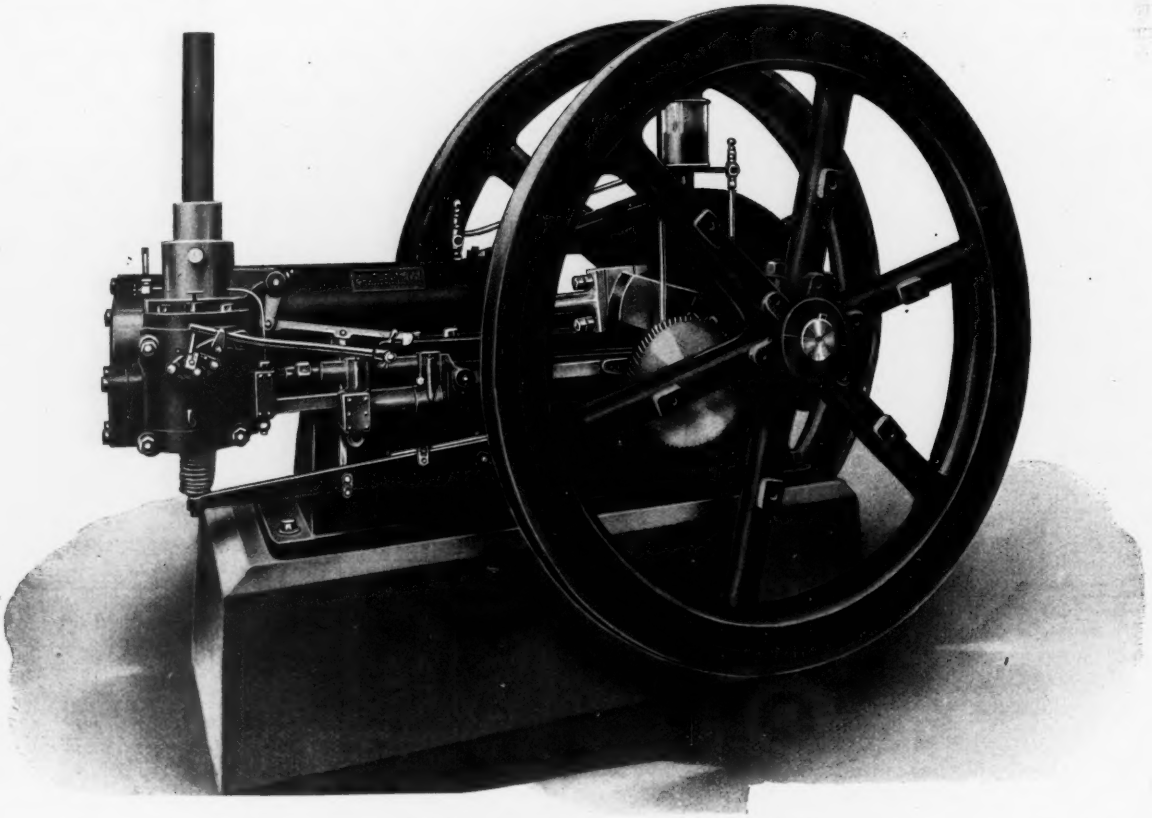


FIG. 1. VIEW OF WESTERN STATIONARY GAS ENGINE

To accomplish this result, the vaporizer transforms the liquid fuel into a gaseous vapor, intimately mixed with air and finely divided water vapor, a combination that produces an expansive and continuous combustion, exerting pressure on the piston throughout its entire stroke and developing the same power with much less strain and wear on all working parts than where no water vapor is injected.

The bed of Western engines is of rigid design with main bearings set at an angle so that the thrust of the working stroke does not come on the parting line between box and cap. The cylinder is fastened to its seat on the bed, and is water-jacketed as is also the cylinder

head. The piston is of the long trunk type with 4 lap-joint rings and the wristpin is inserted and fastened in place from the front end. So there are no holes through the piston walls.

Flywheels are provided with split hubs and rigidly clamped to the shaft but are also keyed. To the flywheel hub is attached the centrifugal governor which controls the speed on the hit-and-miss principle. By turning a thumbscrew, the speed of the engine can be varied to suit requirements while the engine is in operation. The movement of the pump crosshead serves also to operate the igniter which is of the make-and-break type.

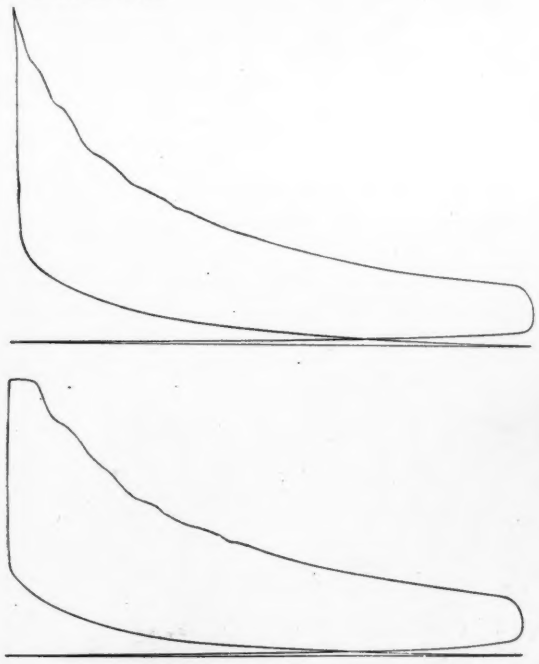


FIG. 2. CARDS FROM WESTERN ENGINE; NO. 1 WITHOUT WATER VAPOR, NO. 2 WITH WATER VAPOR

Simplicity of the valve arrangement is evident from Fig. 3, which is a cross-sectional view through the working end of the cylinder. As the inlet valve opens, the piston is moving forward in its cylinder on its first stroke and the air rushes in taking up correct quantities of fuel and water which are thoroughly vaporized and mixed with the air in passing over the hot exhaust valve head, thereby helping to keep the valve cool and making it much more durable than passing on into the cylinder. The engine works on the 4-cycle principle.

"KEYSTONE" A VALID TRADE-MARK

THE word "Keystone" as applied to greases and lubricating oils belongs to Augustus C. Buzby, doing business as the Keystone Lubricating Co., because of his introduction of his product under that name in 1885. This is the decision of the United States District Court for the Northern District of Illinois. The suit in which the validity of this trade-mark was established was fought between the Keystone Lubricating Co., of Philadelphia, Pa., and the Keystone Oil & Manufacturing Co., of Chicago, Ill. It was the complaint of the former that the Chicago concern had incorporated in 1900 under the name "Keystone" with the deliberate intention of committing frauds upon the trade, and the court holds that such was the case, despite the fact that the product of the company was not marked with the trade-mark, nor sold as "Keystone" grease. The chief witness in the trial was the firm of Hibbard, Spencer & Bartlett, of Chicago, which submitted a bid for a government contract for Keystone Grease, and which by mistake called upon the Chicago "Keystone" company for estimates. The order was awarded to the Hibbard concern, but on delivery the fraud was discovered.

In declaring the Chicago "Keystone" an infringer of the rights of the Pennsylvania company, the court took into consideration the proven fact that a number of garage owners had been misled into buying the

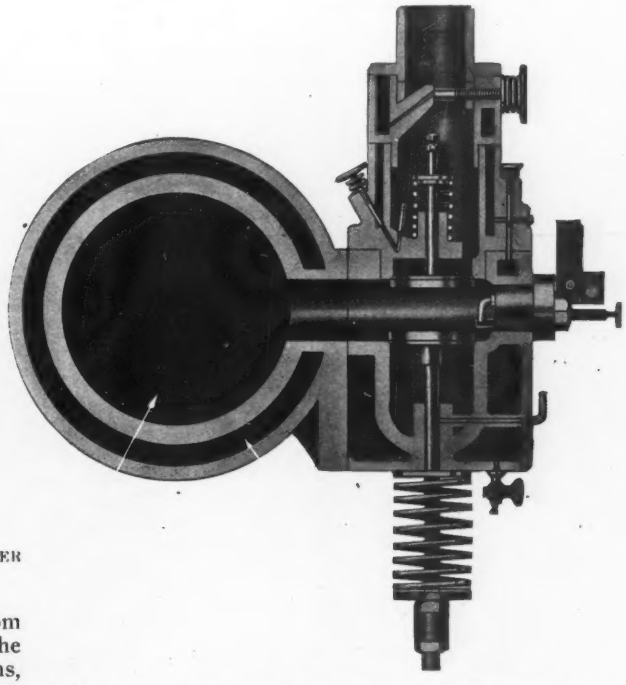


FIG. 3. CROSS-SECTIONAL VIEW THROUGH WORKING END OF CYLINDER

wrong "Keystone" product, finding upon delivery that "Banana" Grease and similar lubricants had been shipped by the Chicago company. The court thereupon decided that "the complainant having a valid trade-mark, the defendant had no right to use the word 'Keystone' in its corporate name, so far as the sale of lubricating grease by it is concerned, if the public is thereby misled. The instances cited show that the similarity of names causes confusion and mistake, and are thought to be sufficient to justify the claim of fraud made by the bill. Defendant does not infringe the trade-mark by marking his goods, but by using the same name to indicate its product. Confusion and mistake result, and this is sufficient to entitle the complainant to the relief prayed."

The court ordered that the Chicago concern should incorporate its lubricating grease business under some other name, or adopt some other plan to avoid infringement.

ELLIOTT VERTICAL-CYLINDRICAL HEATER

ONE of the recently developed types of feed water heaters which have been placed upon the market by the Elliott Co. of Pittsburgh, is known as the vertical-cylindrical heater, type CD. This is made of cylindrical cast-iron flanged sections, flanges being machined and the different sections held together by bolts, with joints made tight by the use of special gaskets. The general form of the heater will be noted in Fig. 1, and it will be seen that the top head is provided with a vent for removing the accumulated air and gases formed in the heater.

For this type of heater, a cutout valve is provided, which consists of a combined separator plate and valve. A bronze ring inserted in one of the outer grooves acts as a valve ring, and bears on the valve seat in the steam nozzle of the heater. The combined valve and separator is mounted to slide on supporting studs. One end of the valve stem extends through and has a threaded engagement with a bar extending across the seat; the other end extends through the wall of the heater and is provided with the usual valve wheel.

By manipulating the valve wheel, the heater can be put in and out of service at will. The advantage of this construction is that the piping of the heater is simplified as well as cheapened, by eliminating the gate valve on the heater steam inlet.

Attached inside the shell of the vertical heater, below the inlet nozzle, is the overflow box, which conducts the oil and entrainment caught by the separator to the overflow outlet. A horizontal opening on the inside wall acts as a skimmer for the light impurities floating on the water surface, and provides an overflow between the heating chamber and overflow box.

The contents of the overflow box runs to waste through the water sealed opening, or when back pressure is carried on the heater, the outlet to this chamber is provided with a float actuated trap.

Water is admitted through a balanced valve controlled by a ventilated float, and is discharged into a cast-iron conduit, which conveys the water to the spray box which has 4 or more V-shaped arms with saw-tooth edges, over which the water flows to the top distributing pan, then flowing in an inward direction, falls on a cascade pan beneath, over which it flows in an outward direction, falling from cascade to cascade, until it passes over the outer edge in a thin sheet into the sediment pans below. It then flows in an inward direction, falling on another cascade pan beneath, and so on until it finally drops into the water chamber.

As the water flows over the ridges of the cascade pans, it is broken up a number of times, and in approaching the outer edge, its depth gradually decreases until in the form of a thin sheet it passes over the outer edge into the pan beneath.

A central column supports the pans in such a way that each individual set is rotatable about its center fastening independently of the adjacent set. The cascade pans are made in 2 sections, bolted together, and are not intended to be removed from the heater for cleaning purposes. The sediment pans, however, are built in segments, the number and size depending on the size of the heater. They are substantially fastened to the cascade pans but in such a manner that no scale can lodge on their supports to prevent their ready removal through the cleaning doors on the side of the casing. To clean the cascade pans, each pan is rotated in front of the cleaning door, the absence of the sediment pan segments allowing ample room for scraping off any scale formed.

A modification of the vertical-cylindrical type is the horizontal-cylindrical heater, the most important difference being that the shell is placed horizontally instead of vertically. In this type, the water enters the heater and is distributed through 2 spray boxes. Heaters of this style are built in capacities up to and including 50,000 hp., and can be furnished either with or without the cutout valve.

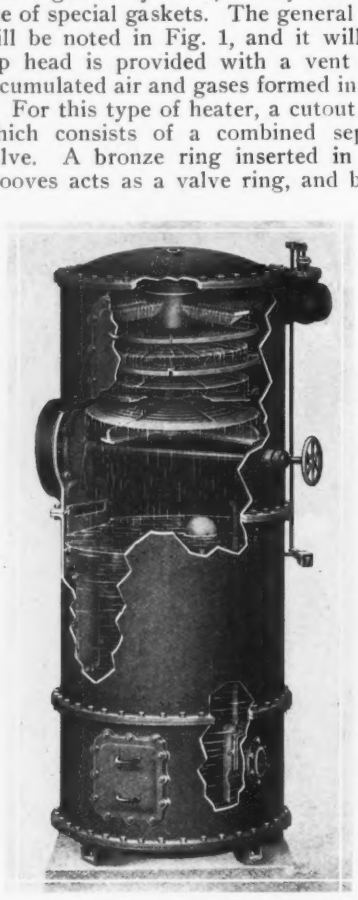


FIG. 1. ELLIOTT VERTICAL-CYLINDRICAL HEATER SHOWING GENERAL ARRANGEMENT

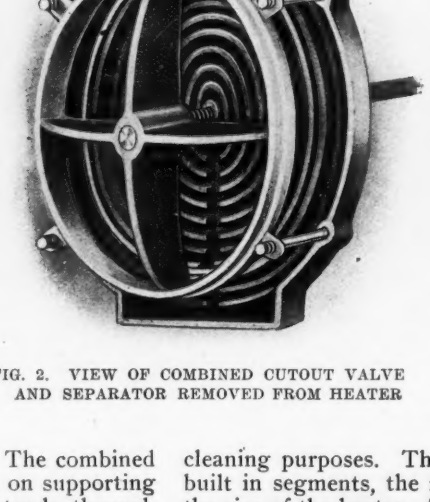


FIG. 2. VIEW OF COMBINED CUTOUT VALVE AND SEPARATOR REMOVED FROM HEATER

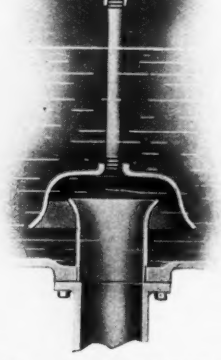


FIG. 3. PUMP SUCTION AS APPLIED TO HORIZONTAL-CYLINDRICAL HEATERS

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

EXTRA HEAVY PIPE

Nom. Size In.	Int. Diam. In.	Int. Area Sq. in.	Metal Thick-ness, In.	Metal Wt. per Ft. Lb.	Contents cu. ft. per 1 Ft. Length	List Price per Ft.
¼	.215	.0363	.095	.314	.00023	.12
⅜	.302	.0716	.119	.535	.00047	.075
½	.423	.1405	.126	.738	.00097	.075
¾	.546	.2341	.147	1.087	.00161	.11
1	.742	.4324	.154	1.473	.00295	.15
1	.957	.7193	.179	2.171	.00493	.22
1¼	1.278	1.283	.191	2.996	.0088	.30
1½	1.500	1.767	.200	3.631	.0122	.365
2	1.939	2.953	.218	5.022	.0204	.505
2½	2.323	4.238	.276	7.661	.0293	.77
3	2.900	6.605	.300	10.252	.0457	1.03
3½	3.364	8.888	.318	12.505	.0616	1.25
4	3.826	11.497	.337	14.983	.0796	1.50
4½	4.290	14.455	.355	17.611	.100	1.80
5	4.813	18.194	.375	20.778	.1265	2.08
6	5.761	26.066	.432	28.573	.1805	2.86
7	6.625	34.471	.500	38.048	.24	3.81
8	7.625	45.663	.500	43.388	.317	4.34
9	8.625	58.426	.500	48.728	.406	4.90
10	9.750	74.662	.500	54.735	.518	5.48
11	10.750	89.76	.500	60.075	.634	6.10
12	11.750	108.41	.500	65.415	.754	6.55

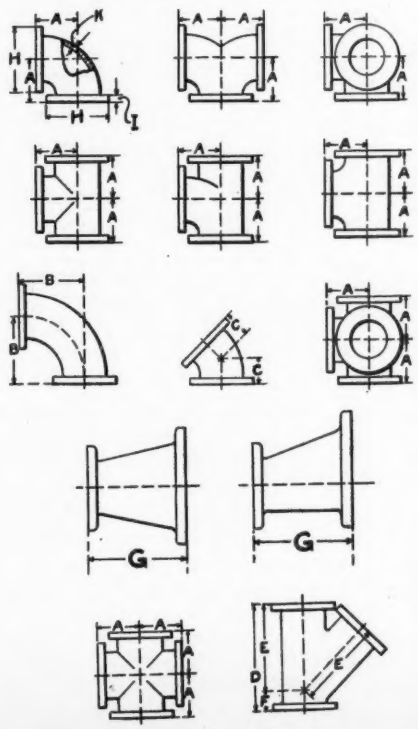
DOUBLE EXTRA HEAVY PIPE

Nom. Size In.	Int. Diam. In.	Int. Area Sq. In.	Metal Thick-ness, In.	Metal Wt. per Ft. Lb.	Contents Cu. ft. per 1 Ft. Length	List Price per Ft.
¼	.252	.0499	.294	1.714	.00033	.32
⅜	.434	.1479	.308	2.440	.00097	.35
½	.599	.2818	.358	3.659	.00188	.37
¾	.896	.6305	.382	5.214	.00428	.525
1	1.100	.9503	.400	6.408	.00646	.65
2	1.503	1.774	.436	9.029	.0121	.91
2½	1.771	2.461	.552	13.695	.0168	1.37
3	2.300	4.155	.600	18.583	.0285	1.86
3½	2.728	5.844	.636	22.850	.0402	2.30
4	3.152	7.803	.674	27.541	.0536	2.76
4½	3.580	10.06	.710	32.530	.0694	3.26
5	4.063	12.96	.750	38.552	.0900	3.86
6	4.897	18.84	.864	53.160	.1295	5.32
7	5.875	27.11	.875	63.079	.1880	6.35
8	6.875	37.12	.875	72.424	.2580	7.25

PRACTICAL ENGINEER

STANDARD FLANGED FITTINGS

STRAIGHT SIZES



PRACTICAL ENGINEER

EXPLANATORY NOTES ON FLANGED FITTINGS

1—Standard and extra heavy reducing elbows carry same dimensions center to face as regular elbows of largest straight size.

2—Standard and extra heavy tees, crosses and laterals, reducing on run only, carry same dimensions face to face as largest straight size.

3—If flanged fittings for lower working pressure than 125 lb. are made, they shall conform in all dimensions, except thickness of shell, to this standard and shall have the guaranteed working pressure cast on each fitting. Flanges for these fittings must be standard dimensions.

4—Where long radius fittings are specified, it has reference only to elbows which are made in 2 center to face dimensions and to be known as elbows and long radius elbows, the latter being used only when so specified.

5—All standard weight fittings must be guaranteed for 125 lb. working pressure and extra heavy fittings for 250 lb. working pressure, and each fitting must have some mark cast on it indicating the maker and guaranteed working steam pressure.

6—All extra heavy fittings and flanges to have a raised surface of 1/16 in. high inside of bolt holes for gaskets. Standard weight fittings and flanges to be plain faced. Bolt holes to be ⅛ in. larger in diameter than bolts. Bolt holes to straddle center line.

7—Size of all fittings scheduled indicates inside diameter of ports, except for extra heavy fittings 14 in. and larger when the port diameter is ¾ in. smaller than nominal size.

8—The face to face dimension of reducers, either straight or eccentric for all pressures, shall be the same face to face as given in table of dimensions.

PRACTICAL ENGINEER

GENERAL DIMENSIONS—STANDARD FLANGED FITTINGS—STRAIGHT SIZES

(All dimensions are in inches)

Size	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62
AA	40	44	46	48	50	52	54	56	58	60	62	64	66	68	70	74	78	82	84	88	90
A	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	37	30	41	42	44	45
B	31½	34	36½	39	41½	44	46½	49	51½	54	56½	59	61½	64	66½	69	71½	74	76½	79	81½
C	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
D	46	49½	53	56	59																
E	37½	40½	44	46½	49																
F	8¾	9	9	9½	10																
G	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62
H	29½	32	34½	36½	38½	41½	43½	46	48½	50½	53	55½	57½	59½	61½	64	66½	68½	71	73	75½
I	1 11/16	1 11/16	2	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16	2 1/16
K*	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16

*Minimum.

EXPLANATORY NOTES

9—Square head bolts with hexagonal nuts are recommended. For bolts, 1⅝ in. diameter and larger, studs with a nut on each end is satisfactory. Hexagonal nuts for pipe sizes 1 to 46 in., on 125-lb. standard, and 1 to 16 in. on 250-lb. standard can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 48 to 100 in. on 125-lb., and 18 to 48 in. on 250-lb. standards, can be conveniently pulled up with box wrenches.

10—Twin elbows, whether straight or reducing, carry same dimensions center to face and face to face as regular straight size ells and tees. Side outlet elbows and side outlet tees, whether straight or reducing sizes, carry same dimensions center to face and face to face as regular tees having same reductions.

11—Bull head tees or tees increasing on outlet, will have same center to face and face to face dimensions as a straight fitting of the size of the outlet.

12—Tees and crosses 9 in. down, reducing on the outlet, use the same dimensions as straight sizes of the larger port. Sizes 10 in. and up, reducing on the outlet are made in 2 lengths depending on the size of the outlet as given in the table of dimensions. Laterals 3½ in. and down, reducing on the branch, use the same dimensions as straight sizes of the larger port.

13—Sizes 4 in. and up, reducing on the branch, are made in 2 lengths depending on the size of the branch as given in the table of dimensions. The dimensions of reducing flanged fittings are always regulated by the reductions of the outlet or branch. Fittings reducing on the run only, the long body pattern will always be used. Y's are special and are made to suit conditions. Double sweep tees are not made reducing on the run.

14—Steel flanges, fittings and valves are recommended for superheated steam.

STANDARD PIPE

Nom. Size In.	Circumference, In.		Cross Section Area, Sq. In.		Length of Pipe, Ft.			
					For 1 Sq. Ft. Surface		For 1 cu. ft. Internal
	External	Internal	External	Internal	External	Internal	
⅛	1.272	.848	0.129	0.0572	9.44	14.15	2513.
¼	1.696	1.144	0.229	0.1041	7.075	10.49	1383.3
⅜	2.121	1.552	0.358	0.1916	5.657	7.73	751.2
½	2.639	1.957	0.554	0.3048	4.547	6.13	472.4
¾	3.290	2.589	0.866	0.5333	3.637	4.635	270.
1	4.131	3.292	1.357	0.8627	2.904	3.645	166.9
1¼	5.215	4.335	2.164	1.496	2.301	2.768	96.25
1½	5.963	5.061	2.835	2.038	2.01	2.371	70.66
2	7.461	6.494	4.430	3.355	1.608	1.848	42.91
2½	9.032	7.953	6.491	4.783	1.328	1.547	30.1
3	10.996	9.686	9.621	7.388	1.091	1.245	19.5
3½	12.566	11.146	12.566	9.887	0.955	1.077	14.57
4	14.137	12.648	15.904	12.73	0.849	0.949	11.31
4½	15.708	14.162	19.635	15.939	0.764	0.848	9.02
5	17.477	15.849	24.299	19.990	0.687	0.757	7.2
6	20.813	19.054	34.471	28.889	0.577	0.63	4.98
7	23.955	22.063	45.663	38.737	0.501	0.544	3.72
8	27.096	25.076	58.426	50.039	0.443	0.478	2.88
9	30.238	28.076	73.633	63.633	0.397	0.427	2.29
10	33.772	31.477	90.762	78.838	0.355	0.382	1.82
11	36.914	34.558	109.431	95.033	0.325	0.347	1.51
12	40.055	37.7	127.677	113.098	0.299	0.319	1.27
13	43.982	41.626	153.938	136.287	0.273	0.288	1.04
14	47.124	44.768	176.715	157.485	0.255	0.268	0.903
15	50.26	48.48	201.06	187.04	0.239	0.248	0.77
16	53.41	51.52	226.98	211.24	0.225	0.233	0.68
17	56.55	54.41	254.47	235.61	0.212	0.221	0.61

GENERAL DIMENSIONS—STANDARD FLANGED FITTINGS—STRAIGHT SIZES
(All dimensions are in inches)

Size	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	
AA	94	96	100	102	106	108	112	116	118	120	124	126	130	134	136	138	142	146	148	—
A	47	48	50	51	53	54	56	58	59	60	62	63	65	67	68	69	71	73	74	—
B	84	86½	89	91½	94	96½	99	101½	104	106½	109	111½	114	116½	119	121½	124	126½	129	—
C	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	—
D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
F	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	—
H	78	80	82½	84½	86½	88½	90½	93	95½	97½	99½	102	104½	106½	108½	111	113½	115½	117½	—
I	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	4	4	4½	4½	4½	4½	4½	4½	—
K*	2½	2½	2½	2½	2½	2½	2½	3	3	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	—

*Minimum.

GENERAL DIMENSIONS—STANDARD FLANGED FITTINGS—STRAIGHT SIZES
(All dimensions are in inches)

Size	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20
AA	7	7½	8	9	10	11	12	13	14	15	16	17	18	20	22	24	28	29	30	33	36
A	3½	3¾	4	4½	5	5½	6	6½	7	7½	8	8½	9	10	11	12	14	14½	15	16½	18
B	5	5½	6	6½	7	7½	8½	9	9½	10½	11½	12½	14	15½	16½	19	21½	22½	24	26½	29
C	1½	2	2½	2½	3	3	3½	4	4	4½	5	5½	6	6	6½	7½	7½	8	8	8½	9½
D	7½	8	9	10½	12	13	14½	15	15½	17	18	20½	22	24	25½	30	33	34½	36½	39	43
E	5½	6½	7	8	9½	10	11½	12	12½	13½	14½	16½	17½	19½	20½	24½	27	28½	30	32	35
F	1½	1½	2	2½	2½	3	3	3	3	3½	3½	4	4½	4½	5	5½	6	6	6½	7	8
G						6	6½	7	7½	8	9	10	11	11½	12	14	16	17	18	19	20
H	4	4½	5	6	7	7½	8½	9	9½	10	11	12½	13½	15	16	19	21	22½	23½	25	27½
I	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	1½
K*	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	1¼	1½

*Minimum.

PROGRESS OF THE PANAMA-PACIFIC EXPOSITION

DIRECTOR of Works, D. H. Connick, of the exposition, has officially announced that all the main exhibit palaces will be completed 9 months before the date of opening of the exposition, February 20, 1915. To give an idea of the preliminary work that has been done, 71 acres of land have been reclaimed from the Bay of San Francisco; a high-pressure water system for fire purposes is nearly installed; a low-pressure water system for service is well advanced, and an extensive drainage system is completed so far as the amusement concessions and foreign nations district is concerned, and is being completed in the main exhibit district as the foundations for the buildings are put in. Underground conduits for electric wires for the transmission of light and power are in the same state of progress.

Ten of the big palaces which will constitute the main exhibit feature are under construction, the flooring of all being practically completed and the framework of 3 now rising. Streets, avenues and paths are laid out, tracks ready for conveying material and machinery to all parts of the grounds, and a commodious harbor on the water front is receiving steamers daily with lumber and other building supplies. The great Machinery Building is erected, roofed and floored, and is receiving its covering and the cornices and pillars. In the preparation of the grounds proper, the sites of parks and gardens are graded and receiving their covering of top soil and fertilizer, while the shrubbery and trees for the landscape gardening are all on hand and ready to be transplanted when desired, work for which will begin this autumn.

BOOKS AND CATALOGS

CRANES & HOISTS, by Herman N. Wilda; New York, 1913, 155 pages, 4 by 7 in., with illustrations and diagrams, in cloth binding.

This is one of the Broadway series of engineering handbooks, translated from the German, and designed to furnish details from good practice. It deals with the construction and calculation of cranes, giving complete data as to the calculation and design for the details, the frames, the chains, the pulleys, the brakes, hoisting gear, etc. It is a book specially written for the man who is designing cranes, and for him will be found useful as a handbook of reference and guide in design.

THE LOG BOOK of the Power Plant, a new circular from Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., describes the Lea V-Notch recording liquid meter. Copies of the circular will be mailed on request.

WESTINGHOUSE A.C. WATTHOUR METERS are fully described and illustrated in a folder (4241) just issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Load curves of the different types of meters are also shown.

Motor Driven Dairy, Creamery and Ice Cream Machinery is the title of a pamphlet (Section 3195) from the same company, giving a large amount of valuable data covering the installation of motors in dairies, ice cream factories, creameries, etc. A number of interesting views are also shown illustrating the method of mounting the motors for driving this class of machinery.

THE "MONARCH" SOOT REMOVER for removing soot from boiler tube surfaces, manufactured by the Monarch Steam Blower Co,, Oakwood Ave., Troy, N. Y., is the subject of a pamphlet just received.

FROM CRANE CO., Chicago, we have received Circular No. 64A describing and illustrating Crane automatic stop-check valves.

BAUM OIL FILTER is the subject of Catalog No. 50 just received from E. P. Baum, Keokuk, Ia. Illustrations show sectional views of Baum oil filters and the general arrangement of the Baum gravity oiling system.

A FEW KINDS of steam and power pumps for boiler feeding, for tank or general service, are discussed in Catalog No. D-163 from The Deane Steam Pump Co., Holyoke, Mass.

FROM WAGNER ELECTRIC CO., 6400 Plymouth Ave., St. Louis, Mo., we have lately received illustrated bulletins, No. 101 on Single-phase Motors and No. 102 on Polyphase Motors.

NOVEMBER CIRCULAR from American Mfg. Co., Noble and West Sts., Brooklyn, New York, illustrates the use of "American" manila rope for spring and breast lines and cargo nets of the steamship Huron of the Clyde Line.

NATIONAL TUBE CO., Pittsburgh, Pa., has recently issued an attractive folder about the "Kewanee" air pump union, which is used on the air lines of locomotives, and is tested with 125 lb. compressed air under water before leaving the factory.

INDUSTRIAL OZONATORS are described and illustrated in Bulletin No. 850 from Sprague Electric Works of General Electric Co., 527 West 34th St., New York.

A circular from that company deals with Sprague flexible steel armored conductors and Greenfield flexible steel conduit fittings and tools.

MOTOR-DRIVEN REFRIGERATING and Ice Making Machinery is the title of a publication (Section 3133) just issued by the Industrial & Power Department of the Westinghouse Electric & Manufacturing Co. This pamphlet gives in a concise manner some interesting information on this subject including specific data on motor applications together with actual kilowatt-hours consumption for different plants. A number of illustrations are shown of various installations and a curve is given showing the horsepower required for refrigerating machines of different capacities.

LOW-PRESSURE receiver oil separators, for use in purifying engine exhaust steam which is to be utilized in low-pressure or mixed-flow turbines, are described in Section "E" of the Cochrane separator catalog, issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa. The object of using these separators is 2-fold, first to prevent oil in the exhaust from fouling the turbine blades and passages and the condenser tubes and rendering the condensate unfit for boiler feed, and secondly to remove from the exhaust steam the water of condensation formed in the engine. As each pound of water in the steam entering a low-pressure turbine will cause the consumption of 1 to 2 lb. more steam, it is stated that the separators soon pay for themselves in the saving in steam and in the increased capacity of the turbines. The separators employed for this service have extra large wells or receivers, which serve not only to store water until it can be drained away by the traps, but also act as muffle tanks to smooth out the pulsations in the flow of the steam from the engine.

TRADE NOTES

AMONG THE RECENT CONTRACTS closed for Terry turbines for Government work, one covers 2 50-kw. sets for the United States fuel ship Kanawha, building at the Mare Island Navy Yard, San Francisco. Another includes 2 300-hp. turbines for fire pumps for the Brooklyn Navy Yard, each running at 2600 r.p.m.

THE BRISTOL CO., Waterbury, Conn., has taken over the business of the Goodwin Hollow Set Screw Company and has made arrangements for the exclusive manufacture of the Goodwin patent hollow safety set screws with the dovetailed slots. Better facilities for manufacturing these set screws will be provided and shipments are already being made from the main factory of The Bristol Co.

A NEW PRODUCT introduced by the Caledonian Oil Co., 135 Front St., New York City, is called Inertiaene. It is ready to use, and is prepared for joints in steam, air, water, ammonia, or other pipe lines, for high or low pressure. Experience over a considerable period has shown that the material will not harden in the joints, and that it is not affected by heat or cold. It is spread onto the face of the flange by a special tool, without the use of gaskets, and is stated by the makers to be suitable for wet or dry joints, and for use on rough surfaces.

THE UEHLING SALES CO., 95 Liberty St., New York, has recently been awarded contracts by the U. S. Navy Department, for a total of 36 units of Uehling CO_2 Recorders for the following Navy Yards: 12 Recorders for Brooklyn, 4 for Newport, 4 for Norfolk, 8 for Mare Island and 8 for Puget Sound. Including the above, the Navy Department has purchased between 65 and 70 units of Uehling CO_2 Recorders within the past 2 or 3 yr., principally in multiple machines. The company also reports having just received an order from Corn Products Refining Co., for 6 units of Uehling Co. recorders for its Granite City (Ill.) plant, the same company having in service 16 units of these recorders at Argo, Ill.; 8 units at Pekin, Ill., and 20 units at Edgewater, N. J.

LARGE MANUFACTURERS, and especially those whose raw material and products are of an inflammable character, are adopting measures that will render their buildings absolutely fireproof. Fireproof walls, floors, roofs and ceilings have in many cases prevented the destruction of the shell of a structure, but by providing fireproof doors and partitions, the blaze might have been confined to the room in which it originated. In order to complete its system of fire protection, the Eastman Kodak Co. has just fireproofed the door openings to elevator shafts and stairways of its new office and warehouse building, Rochester, N. Y., with Pyrono doors, made by the H. W. Johns-Manville Co., New York. In outward appearance these are like any other high-grade wood door, the surface being of any natural wood veneer. The basis of Pyrono construction is a core of wood covered with an asbestos sheathing which is first cemented to the wood and afterward driven into it by means of thousands of indentations, making it not only fireproof but air-proof, the sheathing over the core, aided by a hardened adhesive under the veneer, serving to prevent the admission of moisture to the core wood, and thus stopping expansion and contraction under varying conditions of temperature.

PRACTICAL ENGINEER
Trade-mark, Reg. U. S. Pat. Off.
SEMI-MONTHLY
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Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.
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Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $60.00.
Half page, one year, each insertion, $35.00.
Quarter page, one year, each insertion, $20.00.
Eighth page, one year, each insertion, $12.00.
Front cover, $150 per issue.
Other specified positions, regular rate plus 10 to 50 per cent.
Stippled plates used but no heavy black and white plates.
Invoices are rendered monthly and subject to 2 per cent discount within 10 days.

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Per line, 30 cents each insertion.
Advertisements in this section are inserted under regular headings.
No display type allowed, but the first three words may be set in capital letters.
About nine words make a line. Minimum space sold, two lines.
Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.
All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Positions Wanted

POSITION WANTED—By young man as second engineer or will take complete charge of small plant. 7 years' experience. Tools, indicator and references. Sober, industrious and agree with work. Open for engagement by Nov. 1st. Box 15, Argyle, Minn. 11-15-1

POSITION WANTED—Chief engineer, accust. to have charge of large power stations, Steam, Producer gas and Blastfurnace gas. Good on tests, coal and gas analysis. Power house design and construction. Technical education and practical experience. References. Open for engagement. Address Box 323, Practical Engineer. 11-1-3

POSITION WANTED—Am practical, all around engineer and electrician 25 yrs.' experience with Corliss and Turbine engines, A.C. and D.C. generators. Correspondence solicited. Address Box 326, Practical Engineer, 11-15-1

POSITION WANTED—By engineer. At present employed in plant of 2000 H. P. Have had 10 yrs.' experience in large plants. Mass. license. Address Box 327, Practical Engineer. 11-15-1

MR. MANUFACTURER: Does your business require a manager, one who knows what to do and how to do it?

The advertiser enjoys a National reputation as having made good as sales, factory and office manager, manufacturing and marketing a highly competitive mechanical staple, now seeks a change for the best of reasons. Address Box 328, Practical Engineer. 11-15-1

Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well-known boiler specialty in your territory for an old established manufacturer in the power plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, single and compound with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—Every local Engineers' Association to have an assortment of valuable power plant books—Secretary write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED—Secretary of local Engineers' Association to write us at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

WE WANT to sell manufacturers products. Give us prices, terms and territory. Offices in New York, Chicago, San Francisco, New Orleans and Butte, Mont. Address Box 325, Practical Engineer. 11-1-2

WANTED—An additional subscription solicitor wanted to cover towns in the state of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf

For Sale

ENGINES AND GENERATORS FOR SALE—1 100-K.W. engine, direct connected to generator, 110-volt, direct current; 1 250-K.W., same as above; 1 4-in., Size No. 6, 2000-H.P. Blackburn-Smith Feed Water Filter and Grease Extractor. Above apparatus replaced by larger units is reason for selling. J. F. Miller, 457 Hudson Ave., Albany, N. Y. 11-15-1

ENGINES FOR SALE—Two (2) 13 and 20 by 16 Ball and Wood Tandem Compound Horizontal Automatic Center Crank Engines. In first class order and complete, with all regular attachments. Ready for immediate delivery. Price $350.00 each, f.o.b. cars Binghamton, N. Y. F. H. Herring, Inc., 30 Church St., New York, N. Y. 11-15-2

FOR SALE—One 150-H.P. Cooper-Corliss engine with belting and accessories in first-class condition, at a very attractive price. Rochester Drop Forge Co., Rochester, N. Y. 11-15-2

U. S. PATENT No. 1,036,408, Aug. 20, 1912, automatic feeder for steam boilers, for sale at a very reasonable price. John Alfredsan, Box 210, Hibbing, Minn. 11-15-1

OUR MODERN BLUE PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

Patents and Patent Attorneys

FIND OUT FOR YOURSELF what to invent and how to procure and sell a patent for the same. My book, "Inventor's Universal Educator," covers the matter from A to Z. 140 pages, elegantly bound. Also contains 600 mechanical movements and 50 perpetual motions. Price $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C. 11-15-1

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PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 11-1-2

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf

PATENTS SECURED. Legal protection our specialty. Booklet free. Harry Patton Co., Suite 330, McGill Building, Washington, D. C. tf

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

Educational and Instruction

ENGINEERS' POCKET MANUAL. 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather.

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Ave., St. Louis, Mo. 11-15-5

Miscellaneous

ENGINEERS desiring valuable data on Boiler Operation, should write for our new booklet—it's free if you tell us where you saw our ad. The Federal Graphite Mills, Cleveland, Ohio. 11-15-3

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water Purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co. 1413 W. Jackson Blvd., Chicago, Ill. tf

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf

Sparks On The Advertising Pages

It's a great big world—this advertising world,—so busy and so complicated that it does us no harm to view and comment, occasionally, on some of the happenings of its complex parts.

* * *

One of the surprises November has brought in the general magazines is an advertisement of the Autostrap Safety Razor Co. Their advertisement is modeled after a power plant advertisement and shows two smoke stacks, one sending out black clouds of smoke labeled "Blade Waste," and the other stack is free from smoke. Evidently the writer is a follower of Power Plant Advertising.

* * *

Incidentally, this is a branch of advertising classed by itself. Although it is conservative to a degree, you will find some of the best work of the advertising man in its publications. Proof can be found in *the Advertising pages of Practical Engineer.*

* * *

The following paragraph appeared in an advertisement sent out by a manufacturer of patent medicine in Calcutta:

"My Humble Self is the grandson and pupil of that greatly renowned Hakim, late Galeb Ali Sahib, whose wonderful treatments created wonders and astonishments all over India. Therefore, my humble self can take pride that I have become well versed in all that great Unani System can teach us. My humble self can boldly say that medicines prepared by me are all genuine and infallible. My humble self has been practising in Calcutta since the end of the last century and holds testimonials of the best men of the country certifying innumerable wonderful cures performed by me in absolutely hopeless cases. One should not speak much about one's self."

We can infer that the "Insistence on Truth in Advertising Campaign," of the Associated Advertising Clubs of America, has not reached India.

* * *

Momentum was added the beginning of this month to the campaign for Truth in Advertising when one of the leading daily papers in Chicago caused the arrest of a "jewelry auctioneer" for misrepresenting merchandise. One of the charges was that in selling a cheap watch, the auctioneer stated it was a "Howard Model," thereby leading many people to believe it to be a genuine Howard watch. *The day of the falsifier and exaggerator—whether his claims are made orally or in print—is done.*

* * *

Except in a general sense, this "clean-up" is of little interest to the buyers of power plant goods, for, as we have remarked before in these columns, the advertisers in Power Plant Papers have been remarkably free from the sin of misrepresentation.

* * *

You will find fuel-saving grates and apparatus, boilers and engines of proved worth and other efficient plant devices advertised in Practical Engineer. These advertisements are clearly, educationally and logically written. Engineers, Superintendents, Managers, and Owners should keep in touch with developments toward increasing operating efficiency and economy by reading the messages of these manufacturers.

And, when you are "stuck" on a power plant problem, remember that these advertisers have experts who will be glad to have you submit to them any problem in their line. Get the benefit of trained men in prescribing for special conditions.